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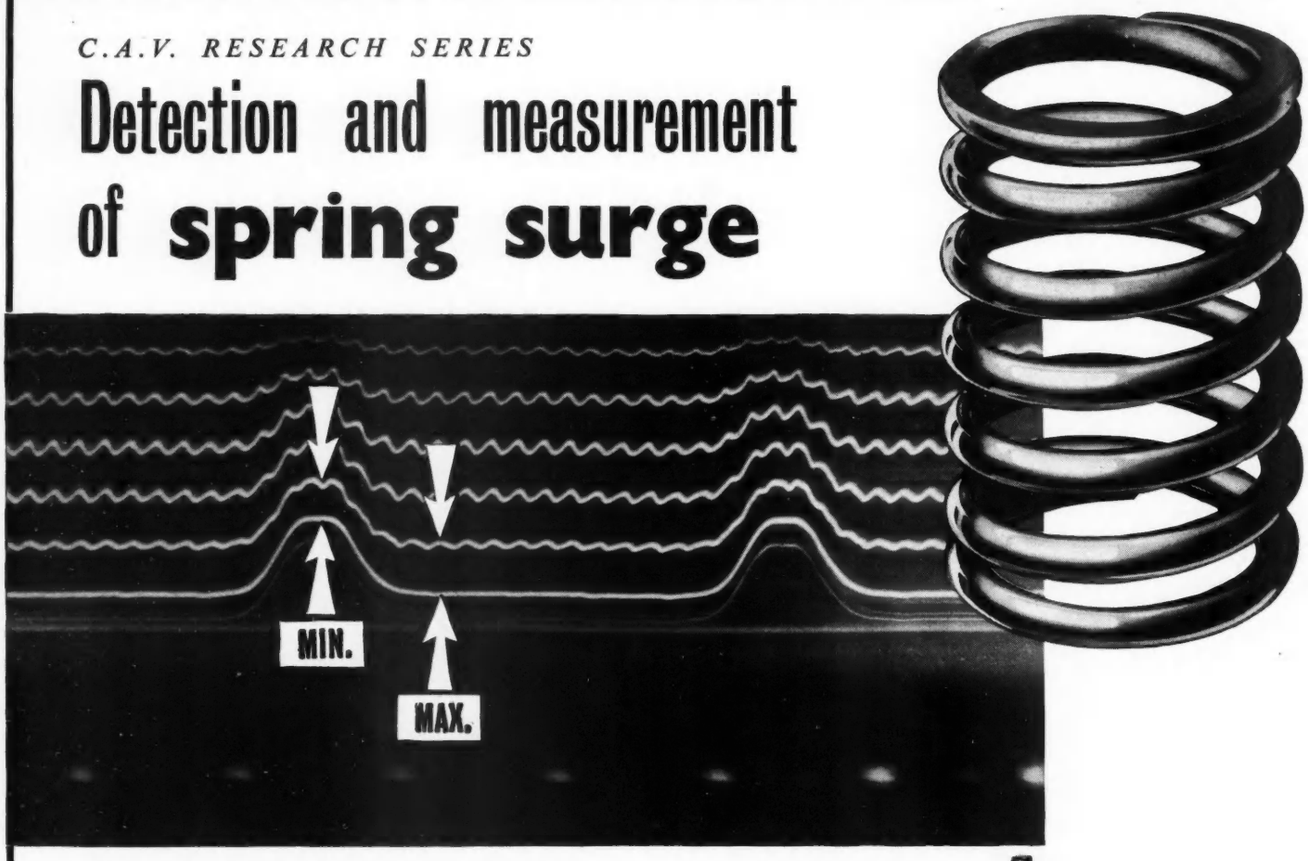
*C.A.V. RESEARCH SERIES*

# Detection and measurement of **spring surge**

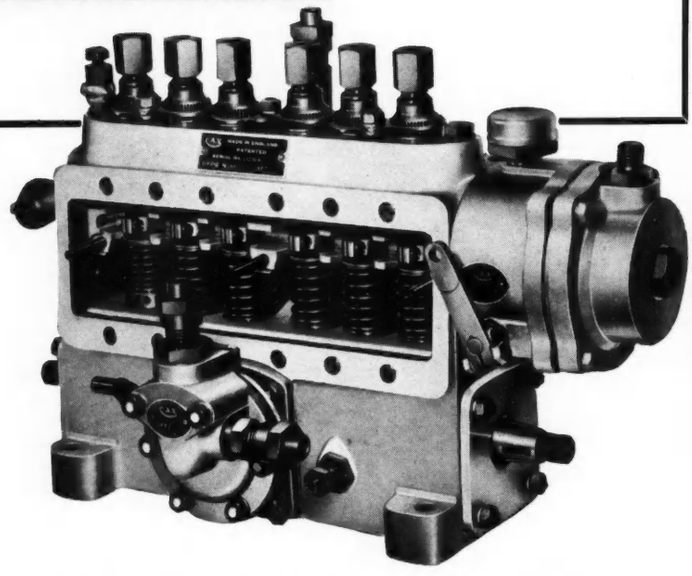



***The firm line shows the cam rise over two cycles. The lower dotted trace shows time intervals of 10 milliseconds.***

When a spring is abruptly compressed, its coils may be caused to "surge", that is, the centre coils are displaced relative to the ends to a greater extent than during the slow compression of the spring, and then vibrate.

Normally, the compression of the spring subjects the material to stresses which are well within its fatigue limit. When the spring surges, however, the oscillation of the coils is added to the normal movement. The stress-range to which the material is subjected is enhanced, and may become excessive.

The illustration above is from a research laboratory record of surge in a spring, the wavy lines showing the displacements of individual coils. The stress range in any turn can be deduced by observing the minimum and maximum turn-to-turn distance.



Surge is an ever-present hazard in coil springs which are compressed abruptly, such as tappet or injection pump plunger springs, and research of this type enables it to be guarded against in the design of equipment.

**Research of this nature guarantees the high quality and performance of C.A.V. Products**

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## POSSIBILITIES OF WIND POWER.

THE cost of electric power, in certain localities and circumstances, is likely to be reduced within the next few years. Extensive work on wind power which has been undertaken in the past four years by several leading electrical, constructional and aircraft firms, backed by research organisations and Government departments, is now showing prospects of commercial application. Indeed, the time has come when wind power can be used in many different ways, provided the engineers who are in a position to advise its use meet the pioneering firms half-way in the task of working out the details of each application.

The obvious disadvantage of wind power—its intermittency—is overcome in various ways. Thus, for example, a wind generator can be used to pump water from a tail-race, or some other water source, up to the headstocks of a high-level hydro-electric plant, where it is used as and when required. For deep-well irrigation of arid areas, a wind generator has the advantage that it does not require fuel oil—a commodity which often, in such areas, has to be imported at considerable expense. In polar regions and other isolated places the same considerations apply. Electricity generated intermittently by wind power can be fed to an electrode boiler, the steam from which is stored in an accumulator; from there the steam can be used, as required, to generate electricity, or it can be used directly for space-heating, water-heating and cooking. Another attractive method of converting the intermittent energy into a useable form is to use the electric output of the wind-driven generator for the electrolysis of water. The resulting hydrogen, bottled or otherwise stored, is then used for cooking, for burning in gas engines, or for driving a machine such as a tractor.

There are also further possibilities in connection with wind power and thermal storage. In the house, the electric cooker can be built to operate on heat-storage principles; space-heating can be undertaken by cabinet heaters, which radiate warmth long after the supply of electricity has been cut off. Latent-heat storage equipment, weighing ounces rather than pounds, is now a possible method of space-heating. On the farm and in the dairy the sterilisation of vessels by means of thermal-storage sterilisers is already a widely used technique in Britain, flash steam being produced by the spilling of cold water on a block of iron or other material, heated by means of small internal elements, the whole being heavily lagged. The storage of meat and produce in refrigerators, again suitably lagged, may be possible for long periods without a continuous supply of electricity. Even more interesting is the use of the floors of buildings as thermal accumulators, heated by elements embedded in or under them. They can be radiating warmth long after the wind has ceased to blow. The energy produced by a wind-driven generator has not been through the thermal cycle, and may be used to operate a heat pump with a reasonable degree of efficiency, and to make a larder or cold store its source of heat and to use the heat thus obtained for warming water in a thermal storage cylinder. In the garden, the capacity of good soil to store heat may be used in a similar way. Glasshouses, frames and lights, cloches, and even open-air beds, may have their soil (just above sub-soil level) heated by means of buried wires so as to provide warmth at the roots of the plants without heating the air above them. The ability of the earth to store heat, even without compost or mulch, is such that considerable periods between winds could be bridged without detriment to growth.

According to the Electrical Research Association, suitable wind-power sites are those which provide a minimum of 4,000 kWh per annum from each kilowatt of installed capacity. There are many such sites in the British Isles. Suitable plant, automatically controlled, would cost 50*l.* per kW. With capital charges at 8 per cent., generation costs would be 0·25*d.* per kWh, which compares favourably with the fuel component of generating cost in a steam power station—at present about 0·4*d.* per kWh.

An exhibition of equipment for the application of wind power was staged last week by Enfield Cables, Limited, Southampton-row, London, W.C.1, at Prae Wood, near St. Albans. This firm is the main contractor to the British Electricity Authority in connection with wind-power development. They have been assisted by the Electrical Research Association, the Ministry of Fuel and Power, and the Department of Scientific and Industrial Research. The 100-kW wind generator on which Enfield Cables, Limited, and other firms have been working is being erected at the Prae Wood site, as shown in Fig. 1, for its first tests. This machine was described on page 213 of our issue of February 13, 1953. It has been designed by de Havilland Propellers, Limited. The English Electric Company, Limited, have designed and manufactured the electrical equipment, and the Redheugh Iron and Steel Company (1936), Limited, have been responsible for the steelwork and erection. The plant works on the "depression" principle, which has been tested on a small scale by Monsieur J. Andreau in France. The propeller blades are hollow, and as they rotate air is discharged through apertures in the blade tips due to centrifugal action; as a result, air is caused to flow through an air turbine near the base of the tower, up through the tower and through the propeller boss to the tips. The alternator and control gear are also housed in the base of the tower.

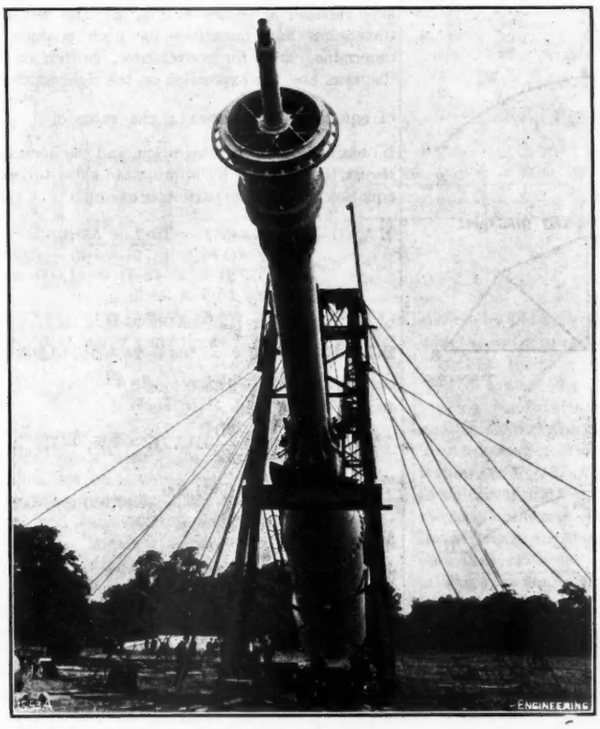



FIG. 1. TOWER OF 100-KW WIND GENERATOR BEING ERECTED.

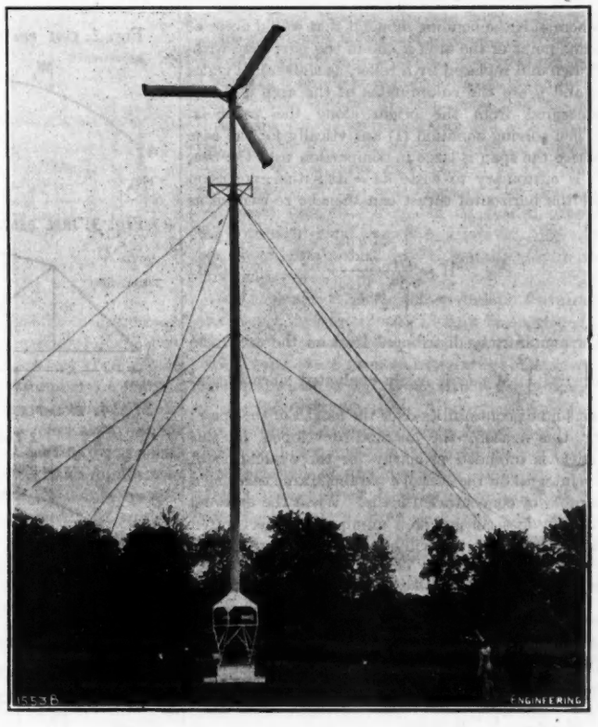



FIG. 2. FRENCH 8-KW WIND GENERATOR.

Also at the exhibition was the 8·5-m. 8-kW plant, of a similar type, shown in Fig. 2. This plant has been built by Ateliers et Chantiers de France, S.A., Paris, to the order of Enfield Cables, Limited, for the Ministry of Fuel and Power. Among the other exhibits were a 30-kW electrode boiler made by G.W.B. Electric Furnaces, Limited, Dudley; a steam accumulator made by the Steam Storage Company, Limited, Leeds (to which a 2½-h.p. steam engine, lent by the National Research Development Corporation, was connected); and a 2½-h.p. petrol engine, modified to run on hydrogen, supplied by R. A. Lister and Company, Limited, Dursley.

# HORIZONTAL THRUST ON A TWO-PINNED PARABOLIC ARCH.

By R. HICKS, B.Sc.

THE long integrations which occur when determining the horizontal thrust in a two-pinned parabolic arch carrying concentrated loads, can be avoided by the use of the method developed in this article. Avoiding the direct integration not only eliminates a considerable amount of labour but, at the same time, reduces the risk of arithmetical error. For such an arch, having a cross-section with a constant second moment of area and loaded as shown in Fig. 1, herewith, the horizontal thrust, H, is given by the expression

$$H = \frac{\int_0^L M\,y\,ds}{\int_0^L y^2\,ds} \quad . \quad . \quad . \quad (1)$$

where M is the bending moment that would occur at some point of the arch if one of the pins were withdrawn and replaced by a roller, as shown in Fig. 2; $x$ and $y$ are the co-ordinates of the arch and $s$ is measured from the origin along the parabola. When solving equation (1) analytically for the case where the span is large in comparison with the rise, it is customary to write $ds = dx$; the expression for the horizontal thrust can then be re-written as

$$H = \frac{\int_0^L M\,y\,dx}{\int_0^L y^2\,dx} \quad . \quad . \quad (2)$$

For a uniformly distributed load on the arch, the integral $\int_0^L M\,y\,dx$ is easily evaluated since it contains no discontinuities over the length of the span; for this reason, the method developed in this article is intended primarily for the evaluation of the integral for the case of a parabolic arch carrying a number of concentrated loads. When the external loading does consist of a number of concentrated loads, however, there will be as many discontinuities in the integral, $\int_0^L M\,y\,dx$, as there are concentrated loads, as the equation for the variable M will change at each point of the arch where there is such a load. Thus, if there are $n$ concentrated loads at distances $x_r$ from the left-hand support, A, then,

$$\int_0^L M\,y\,dx = \int_0^{x_1} M_0\,y\,dx + \ldots . + \int_{x_r}^{x_{r+1}} M_r\,y\,dx \ldots . + \int_{x_n}^{L} M_n\,y\,dx \quad . \quad (3)$$

where $M_r$ is the general expression for M in the region $x_r \leqslant x \leqslant x_{r+1}$. It is obvious that the evaluation of equation (3) will be very tedious when a considerable number of concentrated loads are carried by the arch.

A great deal of laborious analysis can be eliminated, as shown below, if the integral $\int_0^L M\,y\,dx$ is evaluated directly from the free bending moment that is obtained if one of the pins is replaced by a roller. For a parabolic arch,

$$y = \frac{4D\,x\,(L - x)}{L^2}$$

where D is the rise of the arch in the centre and L is the span. Therefore,

$$\int_0^L M\,y\,dx = \int_0^L \frac{4M\,D x\,(L - x)\,dx}{L^2}$$

or

$$\int_0^L M\,y\,dx = \frac{4D}{L}\int_0^L M\,x\,dx - \frac{4D}{L^2}\int_0^L M\,x^2\,dx \quad . \quad (4)$$

The free bending-moment diagram for the arch is given in Fig. 3. It can be seen that $\int_0^L M\,x\,dx$ is the first moment of area of the diagram about a vertical line through the support A, and that $\int_0^L M\,x^2\,dx$ is the second moment; these two quantities are readily evaluated if the bending-moment diagram is divided into elementary triangles each having one side vertical. Suppose there to be $m$ such triangles and the area of the $r$th triangle

Fig. 1. TWO-PINNED PARABOLIC ARCH.

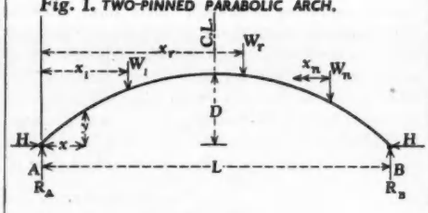



Fig. 2. ONE PIN RELEASED.

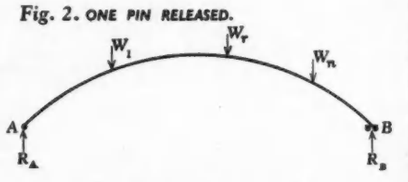



Fig. 3. FREE BENDING-MOMENT DIAGRAM.

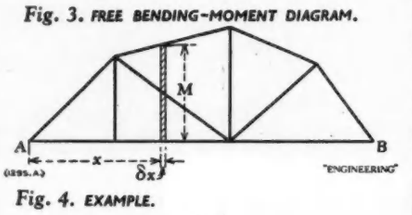



Fig. 4. EXAMPLE.

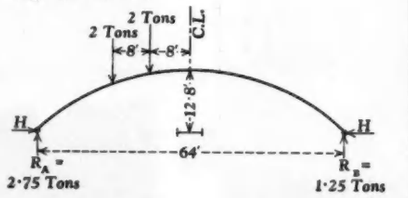
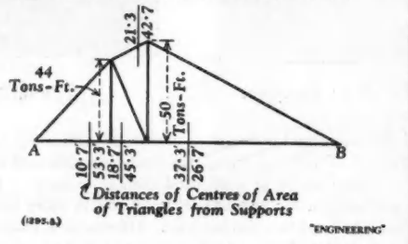



Fig. 5. FREE BENDING-MOMENT DIAGRAM.




be $A_r$, the second moment of area of this triangle about a vertical line through its own centre of area $I_r$ and the distance of the centre of area from the datum line $\bar{x}_r$, then, using the theorem of parallel axes, the second moment of area of this triangle about the datum line can be written down directly as $I_r + A\,\bar{x}_r^2$.

Therefore,

$$\int_0^L M\,x^2\,dx = \sum_1^m (I_r + A\,\bar{x}_r^2) \quad . \quad (5)$$

and,

$$\int_0^L M\,x\,dx = \sum_1^m A_r\,\bar{x}_r \quad (6)$$

Substituting equations (5) and (6) in equation (4) gives

$$\int_0^L M\,y\,dx = \frac{4D}{L^2}\sum_1^m [L\,A_r\,\bar{x}_r - I_r - A_r\,\bar{x}_r^2]$$

or,

$$\int_0^L M\,y\,dx = \frac{4D}{L^2}\sum_1^m [A_r\,(L - \bar{x}_r)x_r - I_r] \quad (7)$$

(For a triangle of height $h$ and base $b$ the second moment of area about a vertical line through its own centre of area is given by $I_r = \frac{h\,b^3}{36}$.) The dimensions of each elementary triangle are readily obtained from the bending moment diagram, and $A_r$, $I_r$ and $\bar{x}_r$ can be calculated in each case. The discontinuous integral $\int_0^L M\,y\,dx$ can be evaluated, therefore, by reading off and summing quantities obtained from this bending-moment diagram.

The method is best demonstrated by a simple example of such an arch carrying two concentrated loads, as shown in Fig. 4, herewith. The free bending-moment diagram for the arch considered as a simply-supported beam is first drawn and then divided into elementary triangles, each with one side vertical, as shown in Fig. 5. The necessary dimensions and quantities for each triangle are determined and, for convenience, written on the diagram, and the expression on the right-hand side of equation (7) evaluated; the value of $\int_0^L y^2\,dx$ is obtained by direct integration, and the horizontal thrust, H, is found by appropriate substitution in equation (2). In the particular example

$$\sum_1^m A_r\,(L - \bar{x}_r)\bar{x}_r = (352 \times 10{\cdot}7 \times 53{\cdot}3) + (176 \times 187 + 45{\cdot}3) + (200 \times 21{\cdot}3 \times 42{\cdot}7) + (1{,}000 \times 26{\cdot}7 \times 39{\cdot}3)$$

$$= 1{,}530{,}000 \text{ tons-ft.}^4$$

$$\sum_1^m I_r = \tfrac{1}{36}[180{,}000 + 22{,}500 + 25{,}600 + 3{,}200{,}000]$$

$$= 95{,}500 \text{ tons-ft.}^4$$

and

$$\int_0^L M\,y\,dx = \frac{4D}{L^2}\sum_1^m [A_r(L - \bar{x}_r)\bar{x}_r - I_r]$$

$$= \frac{4 \times 12{\cdot}8 \times 1{,}434{,}500}{64 \times 64} = 17{,}900 \text{ tons-ft.}^3$$

Also,

$$\int_0^L y^2\,dx = 5{,}600 \text{ ft.}^3$$

and

$$H = \frac{17{,}900}{5{,}600} = 3{\cdot}24 \text{ tons.}$$

It can be shown by trial that this method is much shorter than the direct evaluation of $\int_0^L M\,y\,dx$ for the same figures and it is evident that the process can be extended indefinitely to deal with any number of concentrated loads.

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1954 ELECTRICAL ENGINEERS' EXHIBITION.—The Association of Supervising Electrical Engineers announces that, following on its exhibition at Earl's Court last March, arrangements are now in hand for holding the third National Electrical Engineers' Exhibition in March next year. Information may be obtained from the general secretary, 54, Station-road, New Barnet, Hertfordshire; or from Mr. P. A. Thorogood, 35, Gibbs-green, Edgware, Middlesex.

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"AVRO 504" AIRCRAFT FOR SCIENCE MUSEUM.—One of the last three Avro 504 training aeroplanes believed to be still in existence is to be reconditioned at the Bracebridge Heath, Lincoln, works of A. V. Roe and Co., Ltd., Greengate, Middleton, Manchester, and will then be presented to the Science Museum. For the last 12 years it has been hanging from the roof of the closed and bomb-damaged Corn Exchange building in Hull, where it had been on exhibition in the Transport and Commerce exhibition from 1925 to 1941, and has deteriorated through exposure to the elements and damage from the shattered glass roof. The Avro 504 aircraft, the first type to be produced in quantity, first flew in 1913. The last Avro 504 was built in 1931.

## FLUID-FLOW MEASURING DEVICES.

Fig. 8.

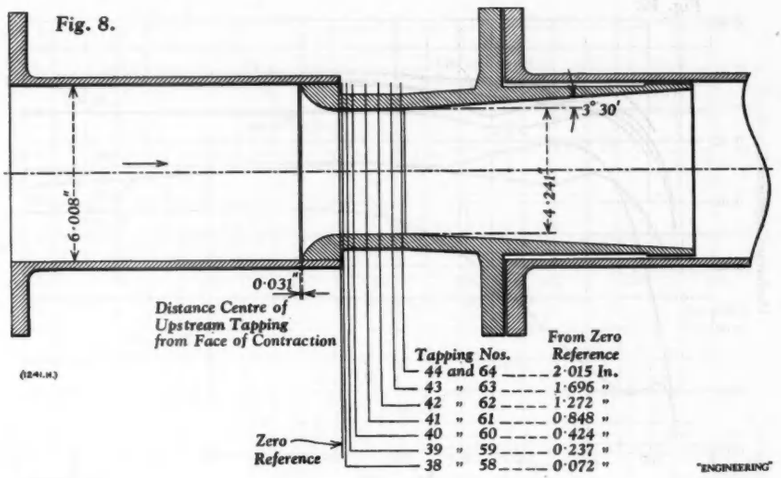
3" 30'
4·241"
6·008"
0·031"
Distance Centre of Upstream Tapping from Face of Contraction
Tapping Nos. From Zero Reference
44 and 64 ____ 2·015 In.
43 " 63 ____ 1·696 "
42 " 62 ____ 1·272 "
41 " 61 ____ 0·848 "
40 " 60 ____ 0·424 "
39 " 59 ____ 0·237 "
38 " 58 ____ 0·072 "
Zero Reference
(1241.H.)
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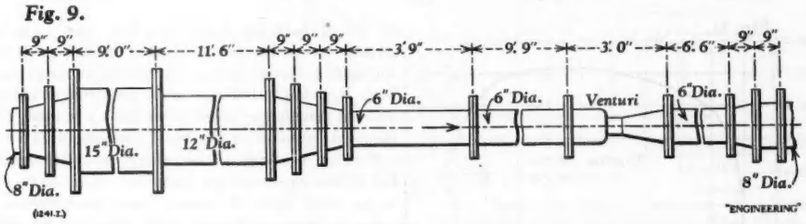
Fig. 9.




## SOME PROBLEMS OF FLUID-FLOW MEASURING DEVICES.

By F. V. A. ENGEL.

(*Concluded from page* 10.)

*Discharge Coefficients of Venturi Tubes.*—This section deals with some results of experiments carried out on a truncated Venturi with an area ratio of $m = 0{\cdot}4981$. The tests were made between April and June, 1938, in the Park Royal works of Electroflo Meters Company, Limited. A full description of the hydraulic laboratory was published in 1936 by the author. A detailed analysis of the results is justified, as no test results already published cover the full range of this particular investigation. The high degree of accuracy essential for this type of work can only be obtained by determining the rate of flow by direct volumetric measurements. In this respect, the above-mentioned test plant once more proved to be of an exceptionally high standard.

Details, including the design of the Venturi and the exact position of the tapping points, are given in Fig. 8. The nozzle of the Venturi was made of high-quality bronze. The diameter of all the tapping holes was $\frac{1}{16}$ in. There were two rows of tapping holes along the Venturi, in two planes forming an angle of 120 deg. This arrangement proved very valuable when deciding the best location for the final tapping and also when investigating the particular behaviour of the fluid in the entrance of the throat section. The Venturi was installed in a pipe line, the arrangement of which is given in Fig. 9. During each test-run the measurement of the differential head was repeated two or three times. Furthermore, a second, independent test was made without any change in the position of the control valve, i.e., for the same rate of flow. The differential head was determined by mercury manometers and, for the low ranges of flow, inverted U-tube gauges, with compressed air on the top, were used to measure directly the pressure difference in water column. The close agreement between readings obtained with both those manometers is illustrated in Figs. 12 and 13, on page 37. Crosses and circles illustrate respectively the measurements with the water gauges and the mercury manometers.

In Fig. 10, page 36, the discharge coefficient is plotted against the Reynolds number for various tapping points along the throat. The Reynolds number in the following sections refers always to the throat diameter. The position of the tapping points is shown in Fig. 8. For lower Reynolds numbers up to values of 150,000, and even 230,000, a marked viscosity influence can be observed. In spite of its variation in the lower range, the discharge coefficient (with the exception of tapping No. 58) is within the limits of $\pm$ 1 per cent. of its constant value for Reynolds numbers exceeding 150,000. A slight change in its characteristic may still occur up to Reynolds numbers of about 550,000 to 600,000 a feature which will be dealt with in one of the following paragraphs. The general trend of the discharge coefficient curves, as indicated in Fig. 10 for the nozzle-type Venturi, has also been found to exist for conical Venturis by Schlag and Jorissen (1947).

As regards the correct location of the tapping points in the throat of the Venturi, Fig. 11, page 36, may be more relevant. This also shows the test points referring to the tappings 38 to 44, which are situated in a plane forming an angle of 120 deg. with those numbered 58 and 64. For all test-points the Reynolds number was 800,000. From the outset, greater discrepancies between both test series may be expected for such tappings as are situated close to the entrance and outlet of the cylindrical throat. The close agreement of the discharge coefficients for the tappings indicated in Table I is rather remarkable. The crosses for Nos. 42 and 43 have not been plotted, as they coincide with Nos. 62 and 63, respectively, and would obscure the diagram.

TABLE I.—*Discharge Coefficients for Various Tappings Along the Throat of a Venturi.*

| Tapping. | Coefficient. | Tapping. | Coefficient. |
|---|---|---|---|
| No. 61 | 0·9383 | No. 41 | 0·9400 |
| ,, 62 | 0·9420 | ,, 42 | 0·9420 |
| ,, 63 | 0·9392 | ,, 43 | 0·9389 |

Tapping No. 62, which corresponds to the position recommended by British Standards, would seem to indicate the best location for the particular throat length. The numerical value of 0·9420 for tapping No. 62 is somewhat higher than that of 0·9356 given by British Standards. The author is not aware of any test with Venturis of a large area ratio, which can claim a higher degree of accuracy than the present investigation. This higher value seems also to be in agreement with a statement made in a recent publication by Ruppel (1951).

The steep gradient of the discharge coefficient close to the entrance section corroborates the corresponding pressure distribution, as given in diagram, Fig. 2, on page 7, *ante*. Most probably the minimum pressure occurs somewhere between tappings Nos. 38 and 58 and Nos. 39 and 59, as indicated in Fig. 11. There is a considerable difference in the characteristic of the discharge-coefficient curve for tappings Nos. 38 and 58 and Nos. 39 and 59. When functionally related to the Reynolds number the curves 38 and 58, as given in diagrams, Figs. 12 and 13, slope steadily upwards until a Reynolds number of about 600,000 is reached. In contrast, curves 39 and 59 show a steeper upward trend, with a break in their characteristic at much lower values, namely, 230,000 and 275,000, respectively. Both these values check up remarkably well with 270,000, the limiting Reynolds number which is generally accepted for an area ratio of 0·5 as the lowest value above which constancy of the discharge coefficient prevails. (See Fig. 1, shaded area in the top, right-hand, corner.) However, this value has been established experimentally for nozzle flow only.

An explanation of the characteristic features of the curves in Figs. 12 and 13 may be suggested on the basis of the following considerations: tappings Nos. 38 and 58 are situated in the range of decreasing pressure, while 39 and 59 are situated in a range of greatly increasing pressure. Under these conditions, viscous-flow characteristics are stable in the first case and rather unstable in the second. Assuming the variation of the discharge coefficient to be mainly related to a boundary layer (which may also be separated from the wall as indicated schematically in Fig. 14, page 37), the question arises whether this "displacement" layer could explain some of the characteristic features as shown in Figs. 12 and 13.

Fully turbulent conditions may prevail over the total length of the cylindrical throat for Reynolds numbers exceeding 600,000. This means that the point of separation has receded into the nozzle-shaped entrance and the laminar boundary layer in the throat has disappeared or broken down.* In these circumstances the thickness of the displacement layer for values smaller than 600,000 may be related to the respective discharge coefficients. The thickness of the displacement layer $\delta$ has been calculated from the following relationships:

$$m^2_\delta = \frac{1}{\left[\frac{C}{C_\delta}\right]^2 \left(\frac{1}{m^2} - 1\right) + 1},$$

$$m_\delta = \left[\frac{d_\delta}{D}\right]^2,$$

$$\delta = \tfrac{1}{2}(d - d_\delta),$$

$m_\delta$, $d_\delta$, being respectively the area ratio and the diameter (both of which are restricted owing to the displacement layer in the throat) and related to specified Reynolds numbers for which these values have been calculated. The corresponding discharge coefficient is indicated by $C_\delta$. C, $d$ and $m$ refer as usual to the actual Venturi dimensions. The numerical values of C, on which the calculation of the displacement layer is based, for both curves of

* Investigations by Jordan (1939) corroborate this statement. Jordan made some experiments with coloured filaments, indicating the type of flow along the wall of a nozzle-shaped contraction.

tappings 58 and 38, have been determined for Reynolds numbers exceeding 600,000, i.e., where C becomes constant. The latter state refers to fully developed turbulence over the total throat cross-section.

In Figs. 12 and 13, the thickness $\delta$ of the displacement layer and the Reynolds number, $Re_\delta = \frac{U\delta}{\nu}$, have been plotted. The results are of great interest. In Fig. 12, a peak value of 2,270 is obtained at a Reynolds number of 230,000 referring to the throat. Coinciding with the latter value there is a breakdown of the predominant viscosity influence of the curve for tapping 59. It must be remembered that this tapping lies in the region of steeply increasing pressure, resulting in instability for boundary-layer flow.

When once the laminar boundary layer has broken down, after a Reynolds number of 2,270 at tapping 58 has been reached, there is no reason why this condition should not prevail, in spite of the rapid drop in the displacement-layer Reynolds number, with increasing throat velocities. This rapid drop is mainly due to a diminishing thickness of the displacement layer. The corresponding values of 2,570 and 275,000, as shown in Fig. 13, are somewhat higher. As this is a stability problem, there is no necessity to obtain identical values all round the wall of the Venturi. Moreover, it is not expected that identical features will be obtained for tappings placed in a different way along the throat; nor for other area ratios. Further research is warranted to complete this investigation. Nevertheless, the close agreement of the "critical" Reynolds numbers with that of 3,000 for the boundary layer related to a flat plate (Schlichting 1949-50 and van der Hegge Zijnen 1926) gives some insight into the flow problems connected with the discharge coefficient characteristics of a Venturi.

The influence of a boundary layer on the discharge coefficient of a conical-type Venturi with an area ratio of 0·22. in the range of medium Reynolds numbers up to 250,000 was established by Pardoe (1941). He found that, in the range of fully developed turbulence, the discharge coefficient remained constant with varying water temperature. For a throat velocity of 10 ft. per second, however, he observed a change in the coefficient of 0·5 per cent. for various temperatures, namely, 0·983 for 74 deg. F. and 0·978 for 46 deg. F. Even plotting the discharge coefficient against the throat Reynolds number indicated a considerable temperature influence, most probably due to the difference in the water and room temperatures.

This, of course, leads to a further aspect of scale effect, as there is no reason to assume a proportional change in both the throat and displacement-layer Reynolds numbers. In the range in which the discharge coefficient is subject to viscosity influence, the coefficient is most probably a function of both the throat and the displacement layer Reynolds number,

$$C = f(Re_d, Re_\delta).$$

In the discussion on his paper, Pardoe pointed out that he would be greatly interested in any suggestions regarding methods of establishing velocity distribution close to the wall of the Venturi, as he thought it unlikely that Pitot-tube measurements could be carried out with any success. The approach to the boundary-layer problem as suggested in the last section of the present article should, therefore, stimulate further research.

*Conclusions.*—As a starting point and a guide for the present paper, Figs. 1 and 1(*a*), on page 6, *ante*, give a comprehensive survey of the influence of geometrical outlines and flow conditions on the discharge coefficient for orifices, nozzles and Venturis. The aims of the present investigations are to achieve greater accuracy, to study the constancy of the discharge coefficients and to determine the limits of reliable measuring ranges. Furthermore, all influencing factors, such as the velocity profile, which may cause changes in the accuracy of the measurements, must be considered. All these problems have been dealt with in the present article, which also discusses some experimental investigations on a Venturi, particularly in the ranges of fully developed turbulence. This, of course, is the most important field of application at the present stage of industrial development.

In the following paragraphs some of the results of the investigation are summarised as follows.

(1) Mathematical investigations have brought nearer a solution of some of the problems, particularly those related to the influence of curved contours of the contracted entrance section (see Fig. 2 and the experimental evidence embodied in Fig. 11) and the influence of the velocity profile in the approach section (Figs. 5 and 7, pages 8 and 9, *ante*).

(2) "Scale effect" should be explained by the velocity profile, which is determined by flow conditions, and the roughness of the conduit, both of which are represented by the friction coefficient. In the case of Venturis, "scale effect" in the range of Reynolds numbers from 100,000 to about 300,000 should be attributed to a "displacement" layer, located close to the throat entrance.

(3) In the case of an orifice, "critical" Reynolds numbers, for example, 140 as a lower value, establish a limit beyond which no constancy of the discharge coefficient may be obtained by features of design (Fig. 3, page 7, *ante*). Another critical number for nozzle and Venturi flow, namely, the Reynolds number in the displacement layer, which was found by experiment to be of the order of 2,200 to 2,600 for $m = 0{\cdot}5$, determines the point in the discharge coefficient curve where viscosity influences cease to be predominant and beyond which constancy of the coefficient prevails.

(4) The flow pattern and also the limit of constancy of discharge coefficients are mainly characterised by a Reynolds number referring to the contracted throat area. Therefore, in accordance with B.S. 1042 : 1943, it must be strongly recommended that future research work should apply this Reynolds number as the basic reference number.

Further research is necessary, and throughout the article problems are indicated which have still to be dealt with. In many instances reference is made to scarcely known work done by previous investigators, which should be of great assistance for obtaining further improvements in the field of fluid-flow measurement based on contracted passages.

# FLUID-FLOW MEASURING DEVICES.

**Fig. 10.**

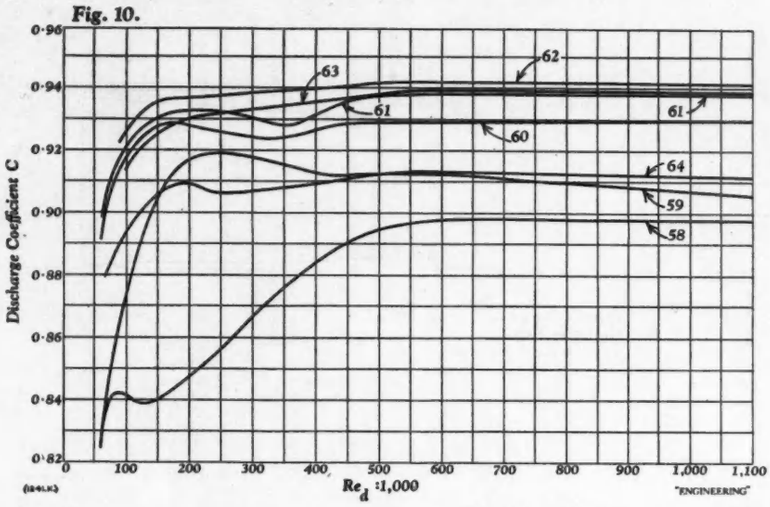
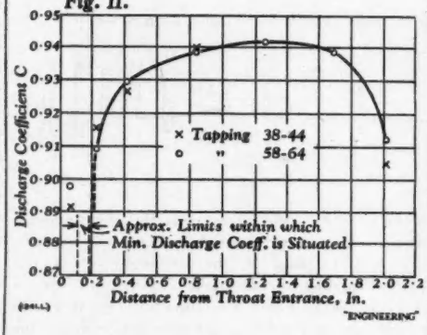



**Fig. 11.**

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## FLUID-FLOW MEASURING DEVICES.

Fig. 12.

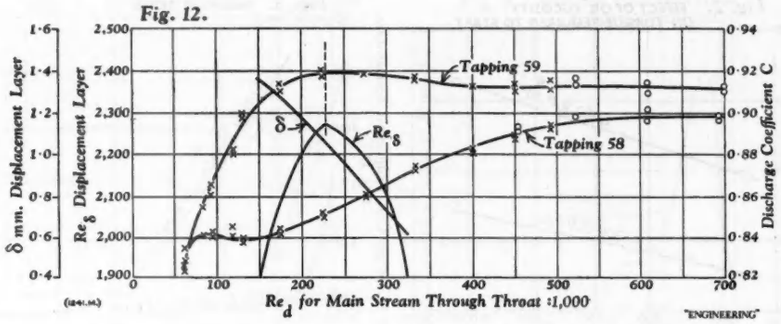



Fig. 13.

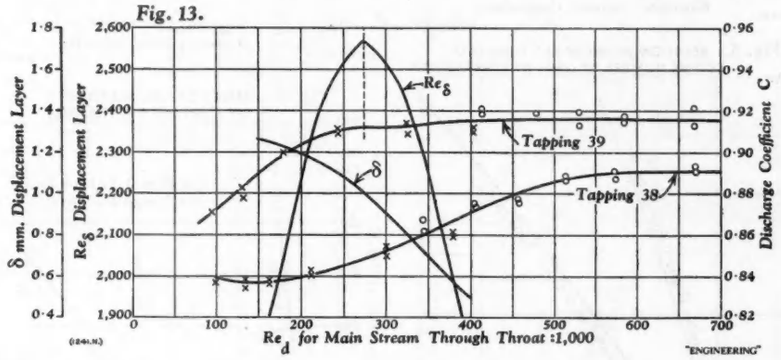
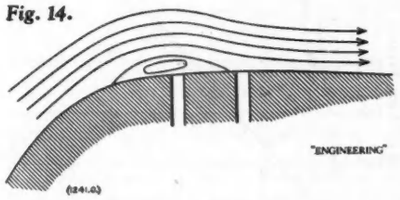



Fig. 14.

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CHANGE OF NAMES OF ROYAL NAVAL COLLEGE.—As from July 1, the title of the Royal Naval College, Dartmouth, has been changed to the Britannia Royal Naval College, Dartmouth, and the ship's name of the college from H.M.S. Britannia to H.M.S. Dartmouth. These changes have been made in consequence of the naming of the new royal yacht H.M. Yacht Britannia. The Royal Naval College assumed the book name H.M.S. Britannia in 1905, when the buildings at Dartmouth were opened and the training of cadets transferred there from H.M.S. Britannia, a screw ship of the line, of 3,994 tons and 115 guns.

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FORMATION OF THE EUROPEAN FEDERATION OF CHEMICAL ENGINEERING.—With the object of obtaining closer co-operation between the various European countries in matters relating to chemical engineering, a European Federation of Chemical Engineering was formally inaugurated in Paris on June 20 last. The new organization owes its origin to efforts which began in 1951, and which were continued during the course of last year's European Convention for Chemical Engineering. Scientific and technical societies in Finland, France, Germany, Holland, Portugal, Spain and Switzerland were represented at the inaugural meeting, and similar bodies in Austria, Denmark, Luxemburg and Norway have expressed their intention of affiliating to the Federation at an early date. The offices of the Federation are located at the Maison de la Chimie, 28, Rue Saint-Dominique, Paris, and at the Dechema-Haus, 25, Rheingaueallee, Frankfurt-on-Main.

## ENGINE RESEARCH ON FUELS AND LUBRICANTS.*

By C. G. WILLIAMS, D.Sc., M.I.Mech.E., F.R.Ae.S., F.Inst.Pet.

ANYONE working in the field of the engine performance of fuels and lubricants soon becomes aware that the design of the engine plays a very important part in his assessment of product quality.

The research worker, studying the engine performance of fuels and lubricants, has to bear in mind those individual design factors, most of which are outside his control, but which influence the results he obtains. This general principle can be expressed simply in a qualitative equation which reads as follows:

$$\left\{\begin{matrix}\text{Quality of}\\\text{mechanical design}\end{matrix}\right\}\times\left\{\begin{matrix}\text{Quality}\\\text{of fuel}\end{matrix}\right\}\times\left\{\begin{matrix}\text{Quality}\\\text{of lubricant}\end{matrix}\right\}=\left\{\begin{matrix}\text{Quality of}\\\text{performance}\end{matrix}\right\}. \quad (1)$$

I would like to give some examples of this relationship, and of what I mean by quality of mechanical design, and quality of fuel and lubricant.

The ability of a motor-car engine to start under cold conditions can be improved by attending to various features of design, such as the size of the battery, the design of the starting motor, the type of carburettor to ensure an appropriate rich mixture, and so on. On the other hand, starting can also be improved by adequate volatility of the fuel, and by using what is popularly described as a "thin" lubricating oil, i.e., one of low viscosity.

My next equation illustrates this relationship:

$$\left\{\begin{matrix}\text{Quality}\\\text{(size) of}\\\text{starting}\\\text{equipment}\end{matrix}\right\}\times\left\{\begin{matrix}\text{Quality of}\\\text{carburettor}\\\text{design}\\\text{(mixture}\\\text{richness)}\end{matrix}\right\}\times\left\{\begin{matrix}\text{Quality}\\\text{of fuel}\\\text{(volatility)}\end{matrix}\right\}\times\left\{\begin{matrix}\text{Quality}\\\text{of lubricant}\\\text{(low viscosity)}\end{matrix}\right\}=\left\{\begin{matrix}\text{Quality}\\\text{of}\\\text{starting}\end{matrix}\right\}. \quad (2)$$

Another performance yardstick of importance is durability or reliability, and one possible trouble can arise from corrosion of certain parts of the engine, such as, cylinder liners. This trouble can be minimised by using materials which have adequate resistance to corrosion, while it can also be minimised by the use of fuels which do not tend to give rise to corrosive products, and by the use of lubricants which provide protection against corrosion. This is illustrated by my third equation:

$$\left\{\begin{matrix}\text{Resistance}\\\text{of material}\\\text{to}\\\text{corrosion}\end{matrix}\right\}\times\left\{\begin{matrix}\text{Quality of}\\\text{fuel (avoidance of}\\\text{corrosive}\\\text{products)}\end{matrix}\right\}\times\left\{\begin{matrix}\text{Quality of}\\\text{lubricant}\\\text{(powers of}\\\text{protection)}\end{matrix}\right\}=\left\{\begin{matrix}\text{Durability}\\\text{(corrosion}\\\text{resistance)}\end{matrix}\right\}. \quad (3)$$

There are many other examples that could be given showing how performance is dependent on both mechanical design and on the quality of the fuel and lubricant, and it is obviously desirable, where possible, for both mechanical design and fuel and lubricant to be developed hand in hand in order to give the best possible performance. Unfortunately, however, in a world of compromise dominated by economics, it is not always possible to have the best of everything. My equations show, however, that if one of the factors on the left-hand side is deficient, then it may be possible to make up for its deficiency by ensuring that the other factors are compensatingly high. I say "may be" advisedly. You will note that I have used a multiplication sign—and not an addition sign—in the above equations so that, if some quality factor is virtually zero, the impossible task is set of requiring one of the other factors to be infinitely high.

I will illustrate what kinds of compensations are possible in the above equations. If, in equation (2), the viscosity of the lubricant is too high, then a compensation is possible by increasing the size of

* Akroyd Stuart Memorial Lecture delivered at Nottingham University on February 20, 1953. Abridged.

# ENGINE RESEARCH ON FUELS AND LUBRICANTS.

Fig. 1. TIME REQUIRED TO START AT DIFFERENT TEMPERATURES.

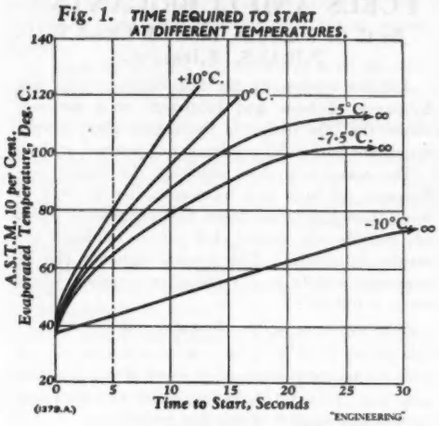



Fig. 2. EFFECT OF OIL VISCOSITY ON TORQUE REQUIRED TO START.

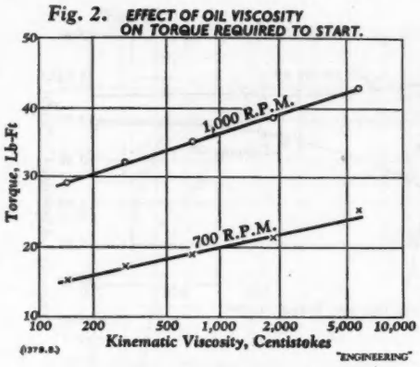



Fig. 3. WARM-UP TESTS.

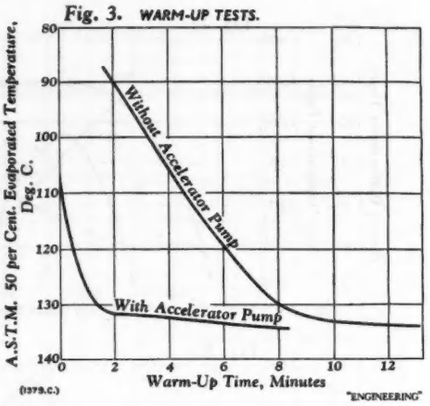



Fig. 4. RELATION OF EASE OF STARTING DIESEL ENGINE TO CETANE NUMBER.

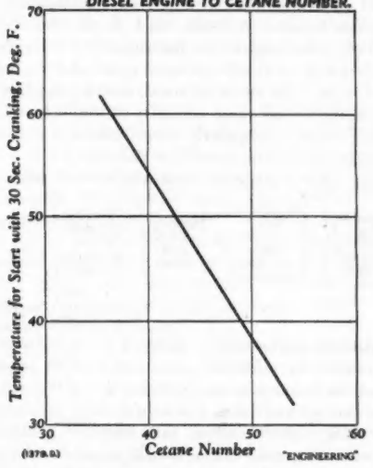



Fig. 5. RELATION BETWEEN ALTITUDE AND CETANE NUMBER AT LIMIT OF STARTABILITY.

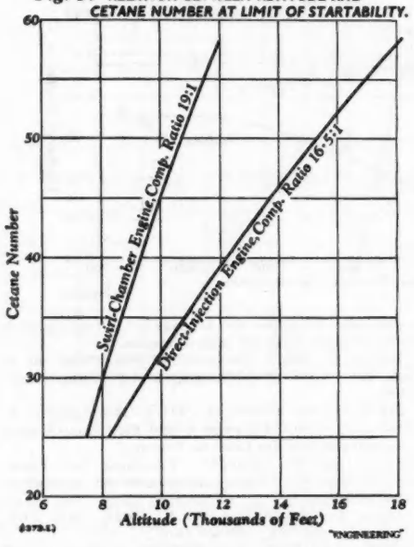
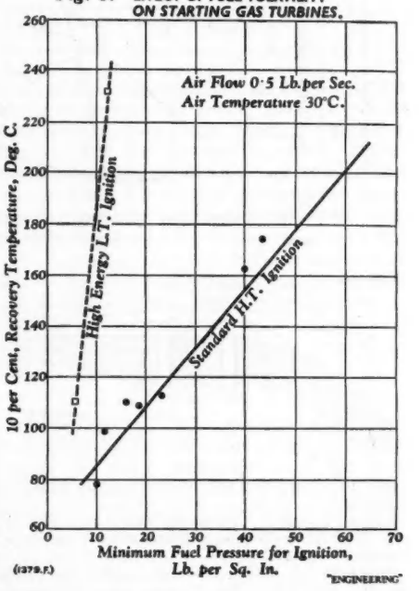



Fig. 6. EFFECT OF FUEL VOLATILITY ON STARTING GAS TURBINES.


Air Flow 0·5 Lb. per Sec.
Air Temperature 30°C.
High Energy L.T. Ignition
Standard H.T. Ignition
10 per Cent. Recovery Temperature, Deg. C.
Minimum Fuel Pressure for Ignition, Lb. per Sq. In.
(1379.F.)
"ENGINEERING"

the starting equipment. Again, if the carburettor does not deliver the right kind of mixture, then, by supplying a fuel of increased volatility, the quality of starting may be maintained. Similar considerations apply to equation (3). For example, chromium-plated piston rings might be used where the protective quality of the lubricant was inadequate, and so on.

It is to ensure that the fuel and lubricant factors in equations such as the above—and many similar ones could be prepared—are sufficiently high that engine research on fuels and lubricants is carried out. It is my intention to give a number of examples, most of which have come within my own personal experience, illustrating the kind of problem which has to be studied, the method used and the kind of result achieved. In giving my illustrations I have drawn upon three types of power plant, viz., the petrol engine, the Diesel engine, and the gas turbine, and, as a measure of performance, I have selected three general criteria, namely: (1) ability to start from cold; (2) thermal efficiency and power output; and (3) durability and reliability. Conditions are frequently difficult for an engine when it is being started from cold, mainly because temperatures are low, and an important range of fuel and lubricant properties contribute towards this item of successful performance.

For example, ease of evaporation, or volatility, is an important factor influencing ease of starting, and Fig. 1 shows the time to start an engine plotted against decreasing volatility. For any given atmospheric temperature, there is obviously a marked tendency for the starting time to increase as volatility diminishes, as would be expected. The effect of increasing the atmospheric temperature is to make starting very much easier so that, for example, a fuel with a 10 per cent. temperature of 60 deg. C. starts in 18 seconds at −10 deg. C., and in 2 seconds at +10 deg. C. For example, if it is decided that 5 seconds is a reasonable time for a start, then a 10 per cent. temperature of 43 deg. C. is required, compared with a 10 per cent. temperature of 80 deg. C. at +10 deg. C. Information of this kind is, therefore, of considerable importance in deciding the volatility of a petrol for summer and winter use.

The viscosity of the lubricant, also, has its effect on ease of starting through its influence on the torque required to turn the engine over. This is shown in Fig. 2. As I have already indicated, the use of an oil of low viscosity would permit a corresponding reduction in the size of the starting equipment.

Not only is it desirable that an engine should start readily, but the warming-up period immediately following is important. To test this, a car was adapted to carry out warming-up tests with artificially cooled air. The apparatus on the roof of the car was virtually a portable refrigerator which cooled the air supplied to the carburettor. With apparatus of this kind, results such as those illustrated in Fig. 3 were obtained. This graph shows the time to warm-up (when the choke can be opened) plotted against a scale of increasing volatility, and the marked effect of volatility in reducing the warm-up time is evident. Fig. 3 is also an illustration of my thesis that it is possible to improve performance by a modification of the fuel or of the engine. In this case, by incorporating a certain feature in the carburettor, an enormous improvement in warm-up time was effected, much greater, in fact, than could be achieved by any practical change in the fuel.

Similar cold-starting studies have to be carried out on Diesel engines and Fig. 4 shows the effect of ignition quality, measured as cetane number, on the lowest temperature at which an engine could be started. It is obvious that by an improvement in ignition quality, a substantial decrease could be achieved in the lowest starting temperature. It is sometimes necessary to operate Diesel engines in mountainous regions where the altitude may be quite substantial, and Fig. 5 shows that, as the altitude is increased, the ignition quality of the fuel to give a successful start should also be improved. This graph also illustrates the argument that a change in engine design can often achieve what is expected of an improved fuel. To start a direct-injection engine at a given altitude requires a very much lower ignition quality than a swirl-chamber engine.

Coming now to the jet engine, there are problems of re-starting at high altitude and Fig. 6 shows the influence of fuel volatility on ease of starting expressed in terms of the fuel pressure required to start. With one type of ignition equipment, as fuel volatility is decreased, it is necessary to increase fuel pressure in order to start. This graph also

# ENGINE RESEARCH ON FUELS AND LUBRICANTS.

Fig. 7. PUMPABILITY OF OILS AT DIFFERENT TEMPERATURES.

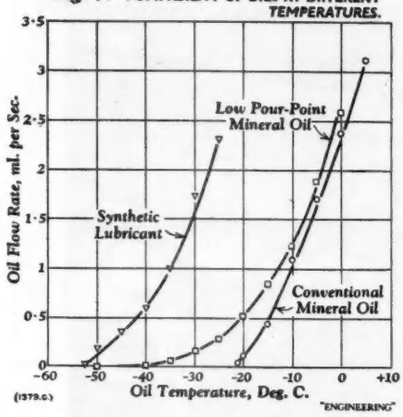
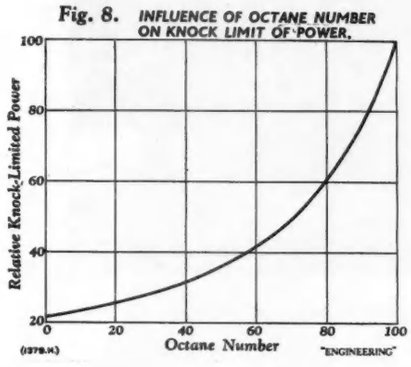



Fig. 8. INFLUENCE OF OCTANE NUMBER ON KNOCK LIMIT OF POWER.




shows the alternative course of improving engine design, in this case by supplying an ignition spark of a different kind. You will notice that an enormous improvement has been effected in ease of starting and that the engine is now largely insensitive to fuel volatility. If this type of ignition equipment is used, it is obvious that the fuel suppliers need not concern themselves with adjustments in fuel volatility in order to give good starting at high altitudes.

I would now like to refer to the kind of lubrication problem which has to be studied in the jet engine at low operating temperatures. Such temperatures may occur, of course, not only when starting, but also under high-altitude conditions, and it is essential that there should be an adequate flow of lubricant to such parts as bearings and gears. Studies on the "pumpability" of lubricants at low temperatures can be carried out on relatively simple apparatus involving a refrigerated supply of lubricant, an oil pump, and methods of measuring pressure and flow. With such apparatus, results of the kind shown in Fig. 7 have been obtained. Oil flow is plotted against oil temperature for three lubricants which, although they have the same viscosity at 210 deg. F., show marked differences in performance at the lower temperatures. The curve on the right, for a conventional mineral oil, indicates cessation of oil flow just below −20 deg. C. The middle curve gives results obtained from a specially prepared low pour-point mineral oil, and shows an appreciable improvement in flow at the lower temperatures. The curve on the left gives results obtained with a so-called "synthetic" lubricant, which can be pumped at temperatures as low as −50 deg. C.

Having, so to speak, got our engine started, the next stage is to consider the influence of fuel and lubricant factors on those performance qualities which are related to efficiency and power. Referring to my

Fig. 9. PEROXIDE CONCENTRATION IN COMBUSTION GASES.

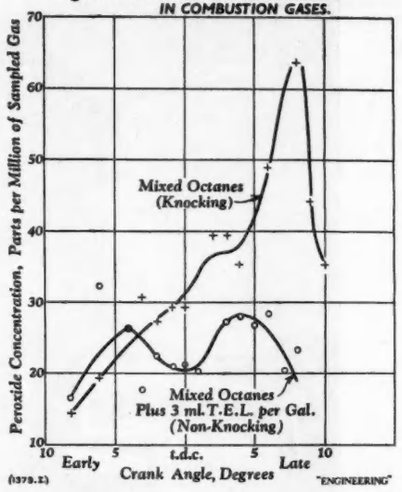
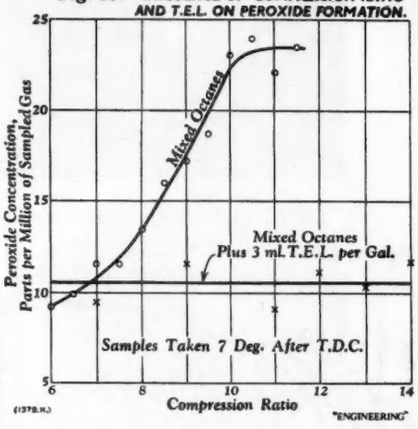


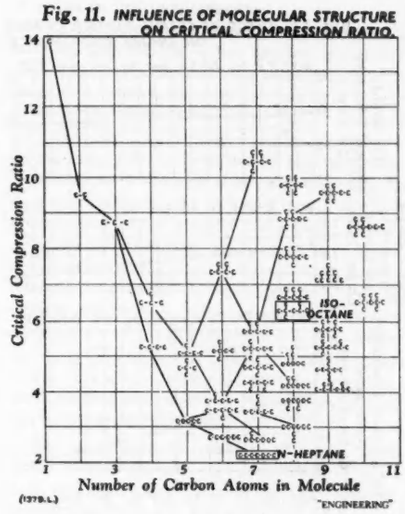

Fig. 10. INFLUENCE OF COMPRESSION RATIO AND T.E.L. ON PEROXIDE FORMATION.


Peroxide Concentration, Parts per Million of Sampled Gas
Mixed Octanes
Mixed Octanes Plus 3 ml. T.E.L. per Gal.
Samples Taken 7 Deg. After T.D.C.
Compression Ratio
(1379.K)
"ENGINEERING"

equation, in which the qualities of mechanical design, fuel properties and lubricant properties are multiplied together to give an overall assessment of performance, it is obvious that mechanical design is a very important factor in determining maximum power output. If we are considering a reciprocating engine, its displacement, its compression ratio, and its degree, if any, of supercharge are all controlling factors, as well as the choice of materials to give adequate fatigue strength, resistance to high temperatures, etc. Fuel properties may play a more or less important part, according to the type of engine. In the case of the petrol engine, there is no doubt that the octane number, or resistance to knock, is the most important criterion. In the Diesel engine, ignition quality is of minor importance, and the same is true of the jet engine. The lubricant may constitute a limiting factor since attempts to increase power usually involve higher operating temperatures, and the lubricant has to be suitably resistant to these higher temperatures.

I would like to illustrate my argument, in the first place, by showing the kind of studies which are carried out to throw light on the nature of knock—a phenomenon with which most motorists have been familiar when using Pool petrol, but one which should now be much less of a nuisance. The important influence which the anti-knock quality of petrol, or its octane number, has on the possible power of an engine is shown in Fig. 8. There is also, as is commonly realised, an important effect on efficiency resulting from increasing the

Fig. 11. INFLUENCE OF MOLECULAR STRUCTURE ON CRITICAL COMPRESSION RATIO.




compression ratio. What is this phenomenon of knock which sets such an important limit on the performance of a petrol engine? A good deal of research has been devoted to this problem.

High-speed photographic studies,* which were carried out in the United States using a transparent head in an engine, have shown the continuous spread of the flame front across the combustion chamber up to nearly the end of combustion when, suddenly, the unburnt portion of the charge explodes almost instantaneously. It is this sudden detonation of the last part of the charge which gives rise to audible knock and which sets a limit to the power and efficiency of the petrol engine. Slight knock is unpleasant for the motorist; heavy knock, is unpleasant for the engine.

What causes this sudden explosion? Studies have been carried out in an engine† with a sampling valve fitted to the combustion chamber, samples of gas being drawn off at various stages throughout the cycle of operations. These samples of gas were then analysed and it was found that among other things, they contained an explosive material described as "peroxides." The build-up of these peroxides throughout the compression and expansion strokes is shown in Fig. 9 and it has been found that when the concentration of these peroxides reaches about 30 parts per million, an explosive reaction, resulting in knock, may occur. The lower curve in Fig. 9 shows the effect of running on an improved fuel, which shows little or no build-up of peroxides. The test conditions for the results plotted in Fig. 9 were: engine speed 1,500 r.p.m., engine-coolant temperature 60 deg. C., intake-air temperature 70 deg. C., mixture strength 12 per cent. richer than c.c.m., and compression ratio, 9·6 : 1.

Thermal efficiency is increased by raising the compression ratio but so is the formation of peroxides and Fig. 10 shows how the peroxide concentration increases with compression ratio, thereby increasing the tendency for knock to occur. The lower curve shows how an improved fuel does not form these peroxides and therefore does not knock. The petroleum refiner is therefore very interested in developing fuels which do not react to form these explosive materials during the compression stroke

* C. D. Miller and H. L. Olsen, "Identification of Knock in N.A.C.A. High-Speed Photographs of Combustion in a Spark-Ignition Engine," *N.A.C.A. Report No.* 761, 1943.

† D. Downs, A. D. Walsh and R. W. Wheeler, "A Study of the Reactions that Lead to 'Knock' in the Spark-Ignition Engine," *Phil. Trans.* A., vol. 243 (1951), page 463.

# ENGINE RESEARCH ON FUELS AND LUBRICANTS.

Fig. 12. EFFECT OF CETANE NUMBER OF FUEL ON ENGINE PERFORMANCE.

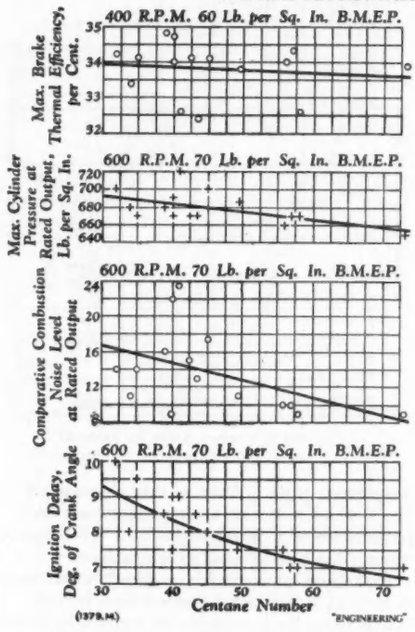
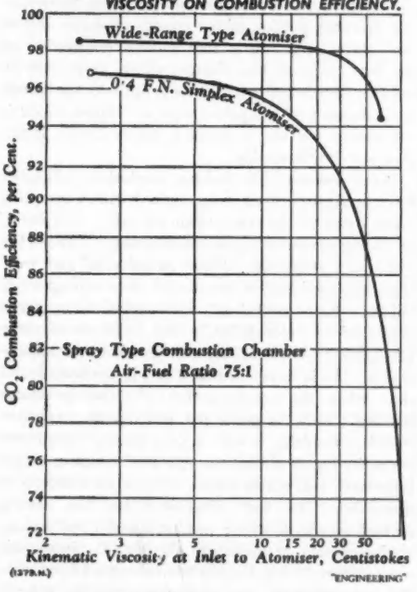

400 R.P.M. 60 Lb. per Sq. In. B.M.E.P.
Max. Brake Thermal Efficiency, per Cent.
600 R.P.M. 70 Lb. per Sq. In. B.M.E.P.
Max. Cylinder Pressure at Rated Output, Lb. per Sq. In.
600 R.P.M. 70 Lb. per Sq. In. B.M.E.P.
Comparative Combustion Noise Level at Rated Output
600 R.P.M. 70 Lb. per Sq. In. B.M.E.P.
Ignition Delay, Deg. of Crank Angle
Centane Number
(1379.M.)
"ENGINEERING"

Fig. 14. EFFECT OF FUEL TEMPERATURE AND VISCOSITY ON COMBUSTION EFFICIENCY.



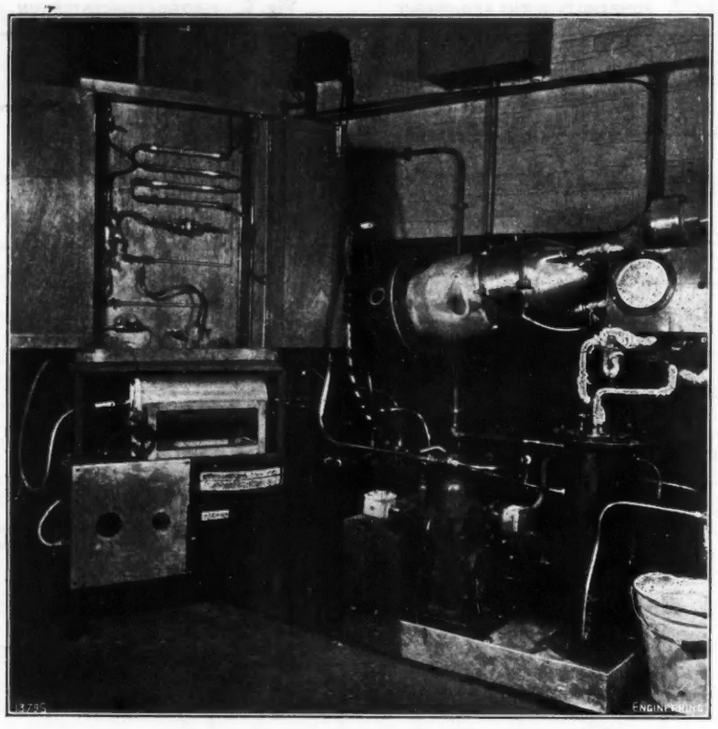



FIG. 13. GAS-TURBINE COMBUSTION CHAMBER WITH GAS-ANALYSIS APPARATUS.

Fig. 15. RELATION BETWEEN COMBUSTION EFFICIENCY AND SPEED OF JET ENGINE.

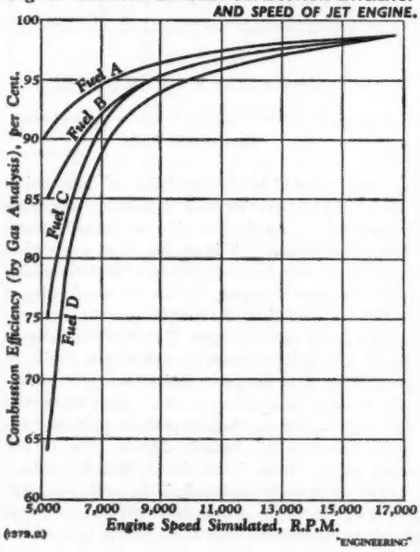
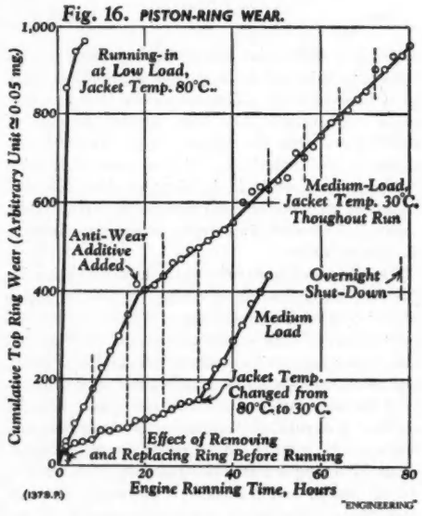



Fig. 16. PISTON-RING WEAR.


Running-in at Low Load, Jacket Temp. 80°C.
Medium-Load, Jacket Temp. 30°C. Thoughout Run
Anti-Wear Additive Added
Overnight Shut-Down
Medium Load
Jacket Temp. Changed from 80°C. to 30°C.
Effect of Removing and Replacing Ring Before Running
Cumulative Top Ring Wear (Arbitrary Units ≈ 0·05 mg)
Engine Running Time, Hours
(1379.P.)
"ENGINEERING"

and Fig. 11, page 39, shows the results of some American studies* on various pure hydrocarbons. In this figure, the maximum compression ratio which the fuel can tolerate is plotted against the "size" of the molecule, measured in terms of the number of carbon atoms it contains. Some of the lighter hydrocarbons, such as methane, are obviously very good anti-knock fuels, but they are beyond the range of what can be readily used, because they are so volatile. Coming to the liquid fuels, it is apparent that, for a given number of carbon atoms in the molecule, there are a number of different arrangements of the atoms in that molecule, some of which give very much better knock resistance than others, even though the molecular composition is exactly the same. It is the task of the engine research worker to indicate which are the desirable molecules and of the petroleum refiner to try to convert as much as possible of the crude oil into such materials. Cat. cracking is one way of doing this.

TABLE I.

| Fuel. | A. | B. | C. | D. |
|---|---|---|---|---|
| A.S.T.M. Distn. Property. | | | | |
| I.B.P. .. .. | 87 | 159 | 184 | 188 |
| 10 per cent. .. | 112 | 174 | 208 | 206 |
| 50 per cent. .. | 163 | 213 | 233 | 222 |
| 90 per cent. .. | 215 | 254 | 273 | 264 |
| F.B.P. .. .. | 236 | 276 | 297 | 309 |
| Aromatic content, per cent. .. .. | 11 | 8·6 | 4 | 23 |
| C:H ratio .. .. | 5·9 | 6·0 | 6·0 | 6·85 |

I would now like to refer to research on fuels for Diesel engines. Here we have a power unit which is not troubled by knock at the end of combustion, but by knock of a different kind at the beginning of combustion, ignition quality or cetane number being a measure of the freedom from such knock. Fortunately, increasing the compression ratio tends to eliminate rather than accentuate this kind of knock, and Diesel fuels do not, in general, impose a limit on power output. Fig. 12 shows some results obtained on a medium-size Diesel engine, in which the influence of cetane number of Diesel fuels on engine performance was ascertained. The top graph shows that there is no consistent effect of cetane number on thermal efficiency while the other graphs show that there is some improvement in combustion smoothness and in maximum pressure attained as cetane number is increased.

* W. G. Lovell, "Knocking Characteristics of Hydrocarbons," *Ind. Eng. Chem.*, vol. 40 (1948), page 2388.

# RESEARCH ON FUELS AND LUBRICANTS.

Fig. 17. PISTON-RING WEAR WITH STRAIGHT MINERAL AND ADDITIVE OILS.

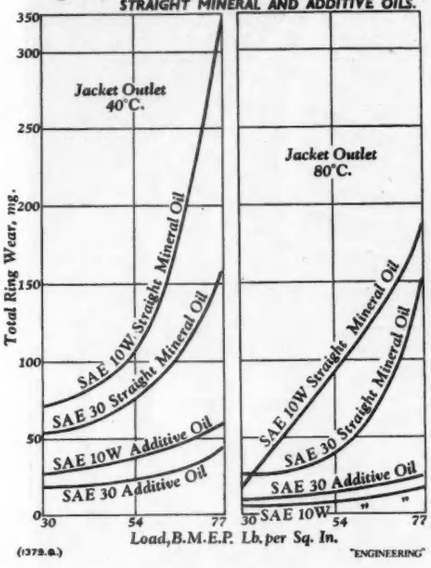



Fig. 18. CORROSION OF COPPER-LEAD BEARING WITH STRAIGHT MINERAL AND HEAVY DUTY OILS.

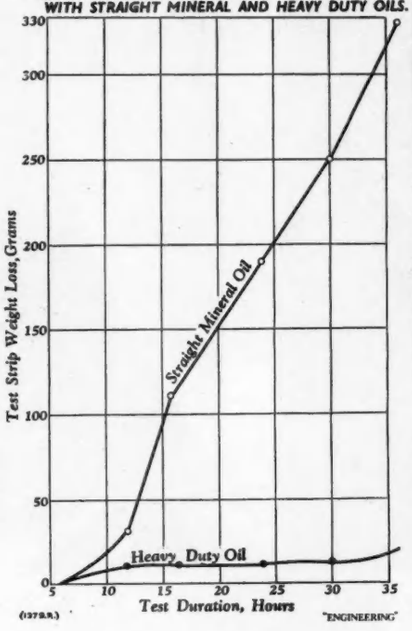


FIG. 19. "TRUMPETING" ON OIL-ENGINE INJECTOR.

FIG. 20. DEPOSIT FORMATION ON SPARK PLUG.

In the jet engine we have the continuous combustion of a spray of atomised fuel and there are no knock problems limiting power output. There are, however, problems of matching fuels to the special demands of this kind of engine, the Fig. 13, opposite, shows the kind of equipment used to study the effect of fuel properties on performance. The combustion chamber, which can be made to operate under altitude conditions, is shown on the right, while gas-analysis apparatus which is used for quickly measuring the efficiency of combustion is shown on the left. As an example of the kind of work carried out, it was necessary to ascertain whether fuel viscosity had an important effect on combustion efficiency. High viscosities may result from cooling a fuel to low temperatures, which may easily occur in jet aircraft. Fig. 14, opposite, shows that, with one form of atomiser, there was a marked tendency for combustion efficiency to fall off above a critical viscosity, this being due to the coarse spray which results from a viscous fluid. This figure illustrates once more that design factors play their part in such matters, the upper curve showing the results of similar experiments carried out with another type of atomiser which is obviously very much less sensitive to fuel viscosity. From work of this kind it is possible to specify what limiting viscosity a fuel should have, if any.

Some other results, showing the combustion efficiency of a jet engine plotted against engine speed, are given in Fig. 15, opposite, for different fuels, particulars of which are given in Table I. The graph shows that, at the lower speeds, certain fuels are better than others, while at the higher speeds, there is little or no difference. A good deal can be achieved by improved design to reduce this difference between fuels so that, in effect, at the lower speeds there can, and should, be little difference in performance between fuels with different properties—one more illustration of the influence of design on fuel requirements.

We now come to our third group of criteria for assessing performance—those relating to durability and reliability. There is little point in having fuel properties which give easy starting and a lot of power if the engine has a short life, or if troubles are incessant. In my basic equation, design of the engine—particularly in terms of the materials of construction—is important in this connection, and so is the quality of the fuel and the quality of the lubricant, as I now intend to illustrate. There are many durability factors which could be included in a discussion of this kind, but I will limit myself to reference to cylinder wear of automobile and Diesel engines, the corrosion of bearings, lacquer deposits on pistons, carbon deposits on atomisers, sludge in engine crankcases, and, finally, to deposits on spark plugs. To all of these matters a good deal of attention has been devoted, from the standpoint of the fuel and the lubricant.

Beginning with the problem of engine wear, I would like to describe the application of a fairly new technique made possible by the existence of the atomic pile at Harwell. By allowing, for example, a piston ring to become irradiated in the pile, the material of the ring becomes radioactive. If such a piston ring is operated in an engine, any part of it which has worn off, however minute, will contaminate the lubricating oil which, itself, becomes radioactive, and, by measuring the radioactivity with a Geiger counter or with some similar apparatus, it is possible to measure wear in a very short space of time without dismantling the engine. Fig. 16, opposite, shows wear plotted against engine running time. This graph demonstrates that wear can be measured quite accurately in a few hours, and the middle curve shows how the effect of adding an anti-wear additive can be measured. The lower curve was obtained at a high jacket temperature, so that the lower rate of wear is due to the avoidance of corrosive wear which occurs at low jacket temperatures. The effect of reducing the jacket temperature towards the end of the test is shown by the immediate increase in rate of wear. The top curve shows the very high rate of wear which occurs when running-in a new engine. This technique is obviously of great interest and value, and will play an important part in wear studies of this kind.

Two important changes which the manufacturer of lubricating oils can make are the addition of a chemical additive and an alteration in viscosity, and it is obviously desirable to ascertain the effect of such changes on engine wear. Such studies have been carried out on a single-cylinder Diesel engine and the results are summarised in Fig. 17. The total piston-ring wear is plotted against load for jacket temperatures of 40 deg. C. and 80 deg. C. and a comparison of the two sets of curves shows the well-known effect of low temperatures in accelerating corrosive wear. There is obviously, also, a marked effect of engine load on wear. A reduction in viscosity from an S.A.E. 30 to an S.A.E. 10W oil results in an appreciable increase in wear, but fortunately, a very substantial reduction in wear can be achieved by using an additive. In fact, the low-viscosity S.A.E. 10W oil, which has certain advantages from the standpoint of starting in cold weather and in reduced engine friction, can be made to give much better wear results than the heavier oil without any additive.

The corrosion of copper-lead bearings which may result in corrosion-fatigue failures, is something which has to be guarded against, and special test methods have been evolved for determining the tendency of lubricants to give rise to this effect. The results of a test, in terms of actual weight loss, are shown in Fig. 18, which illustrates the very large difference that may exist between a good and a bad

# ENGINE RESEARCH ON FUELS AND LUBRICANTS.

FIG. 21. CARBON DEPOSIT ON ATOMISER AIR-SHROUD IN JET ENGINE.

FIG. 22. DEPOSITS ON GAS-TURBINE BLADES.

lubricant. It is necessary to emphasise here that it is only certain bearing materials which are sensitive to this form of corrosion—another illustration of the influence of "design" (in this case, material) on performance.

Deposits of various kinds can occur in a number of different places in an engine, and some of them can be more embarrassing than others. The kind of deposits which can occur on pistons is familiar to most engineers, as is also the difference observed between a "good" and "bad" oil. Many test methods have been evolved for studying these lacquer and other piston deposits, which may result from using an unsuitable fuel, inferior combustion-chamber design, or an inferior lubricant—another example of the inter-relation of design, fuel, and lubricant factors in determining performance. The Diesel engine is susceptible to its own range of problems and when a more "difficult" fuel is used, for example one containing heavy residual components, Fig. 19, page 41, shows the kind of deposits which may accumulate on the injector. This is called "trumpeting" and, as may well be imagined, can interfere considerably with the fuel spray. Obviously, if such a fuel is going to be used some effort must be made, in terms of design, to obviate such deposits.

Another kind of deposit problem may occur on spark plugs and Fig. 20, page 41, shows the difference between a relatively clean and a dirty spark plug. The latter would certainly tend to give a good deal of trouble. These deposits may arise from both fuel and lubricant factors, and, to a certain extent, may be minimised by proper spark-plug design. A good deal of work has been devoted to studies of such deposits in aircraft and motor-car engines, and, as a result, a fuel additive (tricresyl phosphate) has been developed which has shown a marked cleaning-up effect. It is quite frequently necessary, in studying such deposits, to analyse rather small quantities of materials and this can be done by X-ray diffraction apparatus. The passage of X-rays through a sample of the material gives rise to characteristic patterns, from which the composition of the deposit can be ascertained, and a good deal of this kind of work is carried out in association with engine tests.

Still another kind of deposit is shown in Fig. 21. In this case, we are looking towards the atomiser inside one of the combustion chambers of a jet engine, and the carbon which has accumulated will be noted. This carbon deposit may be worse with certain types of fuel, but it can also be aggravated by poor design so that, once again, a fuel property may be called in to compensate for a design factor, or vice versa. In the industrial gas turbine there are incentives to use the cheapest possible fuels which contain residual components. Such fuels have an ash content which may give rise to deposits on the turbine blades, and Fig. 22 illustrates the kind of deposit which may occur. Fortunately, here again, design—in the form of modified combustion conditions—can come to the rescue, and very largely eliminate such deposition troubles.

Having made a number of observations regarding fuels for gas turbines, I would like to mention one problem relating to the lubrication of such engines. These bearings are usually of the ball or roller type, which operate at very high speeds, and, in some cases, tend to get very hot. A lubricant is therefore necessary which will withstand these very high temperatures. (Photographs shown during the lecture illustrated some ball bearings which had operated under various conditions with the outer race at a temperature of 250 deg. C.) The staining visible in the photographs was the result of high-temperature oxidation of the lubricant which, if serious, might interfere with the operation of the bearing. The effect of chemical additives on the performance of the lubricant was also illustrated. A high-temperature bearing test is therefore necessary for the development of lubricants for such engines. If, however, arrangements are made to cool these bearings, which can be done in certain cases, the need for lubricants resistant to very high temperatures may be obviated—one final illustration of the compensating influence of design and lubricant factors.

In concluding this lecture, I am conscious that I have introduced, rather superficially, a large number of subjects, and I hope the effect has not been to confuse you. It was my intention to give a general impression of the kind of work which is being done, rather than to give detailed factual information. I hope I have shown just how closely the behaviour of fuels and lubricants is related to the design of the engine, and that frequently some form of compensation is required between the factors of engine design, on the one hand, and those related to fuels and lubricants, on the other. Finally, I should like to thank the directors of the "Shell" Petroleum Company, Limited, for permission to give the lecture.

## THE PARIS INTERNATIONAL AIR SALON.

THE 20th International Air Salon, organised by the Union Syndicale des Industries Aéronautiques, was held from June 25 to July 5, at Le Bourget airport, Paris. The majority of the exhibitors, naturally, were French, and most of the foreign aircraft and engines on view were well-established machines. This review of some of the exhibits will, therefore, be primarily concerned with developments in the French aircraft industry. Some notes on the structure of the industry will be found on page 50.

As the United Kingdom has set the pace in the development of turbine-powered air transport, so France has established a lead in economical jet-propelled light training aeroplanes, which have aroused considerable interest among other N.A.T.O. countries. This, presumably, has been made possible by development of the successful series of small gas turbines by Société Turboméca, Bordes, Basses Pyrénées. (It may be recalled that, in this country, Blackburn and General Aircraft, Limited, Brough, East Yorkshire, have acquired a licence for the manufacture of Turboméca engines, and an article describing some of their industrial units was published on page 801 of our 175th volume, 1953.)

### FOUGA "MAGISTER" MILITARY TRAINING AIRCRAFT.

Three examples of jet-propelled training aricraft, all undergoing development tests at present, were demonstrated at Le Bourget. Illustrated in Fig. 1 is the Fouga 170R "Magister" twin jet-propelled advanced military training aircraft, designed and constructed by Établissements Fouga et Cie, 90, Rue de Miromesnil, Paris, the pioneer company in the development of light jet aircraft. Their first jet plane, the Sylphe 1, flew for the first time on July 14,

# EXHIBITS AT THE PARIS AIR SALON.

FIG. 1. FOUGA "MAGISTER" TWIN-JET TRAINING AIRCRAFT.

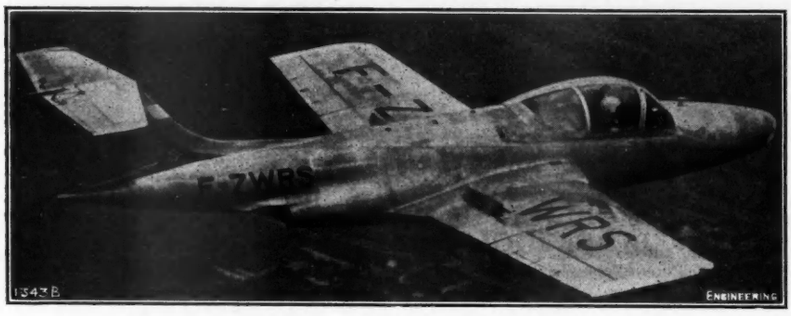



FIG. 2. MORANE-SAULNIER "FLEURET" TWIN-JET TRAINING AIRCRAFT.

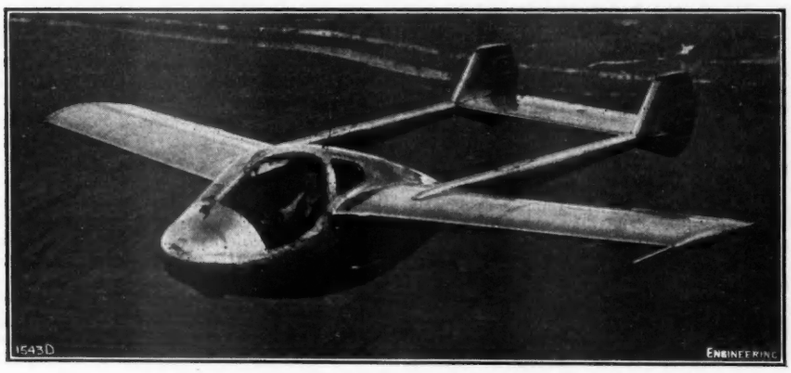



FIG. 4. S.I.P.A. 200 "MINIJET" TRAINING AIRCRAFT.

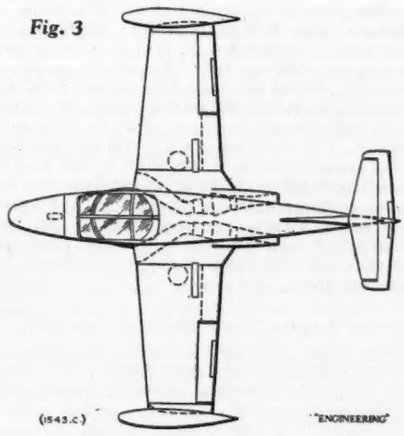
1949, and was powered by a Turboméca Piméné jet engine developing a maximum thrust of 100 kg. Since then several other light aircraft built by the Fouga company have served as flying test-beds for the Turboméca Piméné, Palas, Marboré, and Aspin engines. In 1951, the French air force placed an order for a prototype military jet trainer with the Fouga company, and the Magister, which made its first flight in July, 1952, is the result.

The Magister, which is capable of a maximum speed of well over 400 m.p.h., and is fully aerobatic, has set a new standard in economical operation for twin-jet training aircraft. It is fitted with two Turboméca Marbore II jet engines, each developing a static thrust of 400 kg. (883 lb.). As may be judged from Fig. 1, the aircraft has pleasing lines and the all-metal structure has a high standard of finish. The engines are installed partly in the fuselage and partly in wing-root nacelles. The wing, which is slightly swept back on the leading edge only, is of laminar-flow section and has a single spar. It is fitted with dive brakes and high-lift flaps, hydraulically operated. The retractable Messier tricycle undercarriage is also hydraulic. In common with earlier Fouga jet aircraft, the Magister has "butterfly" tail surfaces, the two tail units being interchangeable and set at an angle of 110 deg.

The instructor and pupil are seated in tandem forward of the wing, in a cabin pressurised by air supplied from the engine compressor, and the aft part of the fuselage, which has an ovoidal section, houses the two fuel tanks, with a total capacity of 730 litres (160 gallons). Auxiliary fuel tanks, each of 130 litres (28·5 gallons) capacity, can be fitted under the wings or at the wing tips. The fuel system is designed for inverted flight. The aircraft is fitted with two machine guns, one camera gun, and bomb and rocket racks. It is also fitted with instrument-flying equipment, two very high-frequency transmitter-receiver sets, a radio compass and inter-communication, and there is provision for oxygen equipment. To increase the view from the rear cockpit, a periscope is provided.

The leading particulars of the Magister are as follows: span, without wing-tip tanks, 11·3 m. 37·2 ft.); length, 9·8 m. (32·1 ft.); height 2·8 m.

*Fig. 3*




(9·2 ft.); wing area, 17·3 sq. m. (186 sq. ft.). The weight empty is 1,936 kg. (4,300 lb.); the maximum permissible all-up weight is 3,200 kg. (7,100 lb.), giving a wing loading of 41 lb. per square foot and a thrust loading of 4 lb. per lb. thrust. Without exterior equipment, the maximum speed at 6,000 m. is 708 km. per hour (440 m.p.h.). The maximum rate of climb at sea level is 16·5 m. per second (3,250 ft. per minute), and the time to climb to 6,000 m. is 9½ minutes. The service ceiling is 10,500 m. (36,000 ft.). The aircraft requires a run of about 540 m. (600 yards) to take off. At 8,000 m. (26,500 ft.), the aircraft has a normal range of 900 km. (560 miles), which can be increased to 12,000 km. (730 miles) with auxiliary fuel tanks.

### MORANE-SAULNIER "FLEURET" MILITARY TRAINING AIRCRAFT.

Designed for similar duties, and also powered by two Turboméca Marboré II jet engines, the M.S. 755 Fleuret military trainer, constructed by Société Morane Saulnier, 3-5, Rue Volta, Puteaux (Seine), flew for the first time in February this year. A photograph of the machine, which appears to be most practical in conception, is reproduced in Fig. 2. Designed for easy servicing, the fuselage is constructed in four sections—the nose, housing the battery, radio, two 7·5-mm. machine guns, and ammunition, camera gun, and oxygen bottles; the pressurised cockpit, with side-by-side seating; the centre section, integral with the centre section wing, which includes the engine intakes, and housing the two engines, a 700-litre (152 gallon) fuel tank, and an oil tank (the arrangement of the engines and intakes is shown in Fig. 3); and the tail section, designed for speedy removal to give access to the engines. The constructors claim that an engine change can be carried out within 30 minutes, including dismantling the rear end of the fuselage, and that, if desired, the twin-jet installation can be replaced by a single-jet unit with very little modification.

A straight wing section has been adopted, relatively thick (12 per cent.) at the root, to give good stalling characteristics. It is provided with flaps and with air brakes extending above and below the wing, electrically actuated, as is also the undercarriage. The tailplane, mounted at the top of the fin, is adjustable in flight. In order to ensure that the pilots are thrown clear of the tailplane in the event of an emergency exit, the pilots' seats are mounted on a hatch in the floor which, on operating the ejector mechanism, swings down and tips the crew out backwards below the fuselage. Alternatively, at low speeds an emergency exit can be made through the hood, which can be jettisoned electrically.

Since the aircraft is intended to provide a full training for jet-fighter operations, the cockpit is pressurised, by air fed from the engine compressor, for high-altitude flight. As an alternative to the two machine guns, four 50-lb. rockets or two 100-lb. bombs can be carried. Two very-high-frequency radio sets, a radio compass and intercommunication equipment are provided. Wing-tip tanks can be

installed, giving an additional tankage of 600 litres (88 gallons).

The principal particulars of the Fleuret are as follow: span, 9·64 m. (31·5 ft.); length, 9·7 m. (31·8 ft.); height, 2·6 m. (8·5 ft.); wing area, 18 sq. m. (193 sq. ft.). The weight, empty, is 1,926 kg. (4,240 lb.) and, fully loaded, 2,697 kg. (5,940 lb.), giving a wing loading of 31 lb. per square foot and a thrust loading of 3·36 lb. per pound thrust. The maximum speed is 780 km. per hour (485 m.p.h.) at 9,000 m. (29,500 ft.); the time to climb to 9,000 m. is 17 to 18 minutes, and the service ceiling is 12,000 m. (39,500 ft.). At 9,000 m. the range, without auxiliary tanks, is 900 km. (560 miles), and with auxiliary tanks, 1,600 km. (1,000 miles). The aircraft requires a take-off run of about 400 m. (440 yards).

### S.I.P.A.200 Light Training Aircraft.

The third jet-propelled training aeroplane at Le Bourget, the S.I.P.A.200 "Minijet," said to be the smallest jet aircraft in the world, aroused great enthusiasm among the spectators at the airfield. Constructed by the Société Industrielle pour l'Aéronautique, 178, Avenue de Neuilly (Seine), it is designed to be suitable for two roles—as a basic jet trainer and short-range communications aircraft, and as a high-speed touring aircraft for private owners. The Minijet, which is shown in Fig. 4, on page 43, has been flying since January, 1952. (The first airframe, exhibited at the 1951 salon without engines, was subsequently used for static strength tests.) It is an all-metal side-by-side two-seat monoplane, powered by a Turboméca Palas jet engine developing a static thrust of 350 lb. The engine is installed in the nacelle body aft of the cockpit, with a bifurcated air intake in the wing roots. The tailplane and fins are carried on tail booms. A hydraulically-operated retractable undercarriage is fitted. The wings are provided with slotted balanced ailerons and double-slotted flaps, the first 20 deg. of flap movement exposing the first slot and the second slot coming into operation only with the full 40 deg. deflection, for landing. The permanent tankage is 215 litres (47·5 gallons), installed partly in the wings and partly in a tank in the fuselage, between the cabin and the engine, which is designed to provide for inverted flight.

The Minijet has a span of 8 m. (26·2 ft.); an overall length of 5·12 m. (16·8 ft.), and a height of 1·78 m. (5·86 ft.). The wing area is 9·6 sq. m. (104 sq. ft.). The maximum all-up weight of the aircraft is 779 kg. (1,675 lb.), giving a wing loading of 16·2 lb. per square foot. As a single-seat aircraft, the machine is stressed for aerobatics. It has a maximum speed, at sea level, of approximately 400 km. per hour (250 m.p.h.), and a cruising speed of 360 km. per hour (225 m.p.h.) at 1,000 m. (3,280 ft.). The maximum range, without tip tanks, is 550 km. (350 miles). With auxiliary wing-tip tanks fitted, a range of 470 miles is possible. The S.I.P.A.200 requires a distance of 300 m. (1,000 ft.) for take-off.

*(To be continued.)*

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**Effect of a Gradient on the Fuel Consumption and Speed of a Road Vehicle.**—The Institution of Mechanical Engineers (Automobile Division), Storey's Gate, London, S.W.1, have invited contributions to a written discussion on a paper prepared by Dr. C. R. Webb, B.Sc. (Eng.), A.M.I.Mech.E., on the following subject: "The Effect of Gradient on Fuel Consumption and Speed of a Road Vehicle." They have requested that all communications be sent to the Institution by October 31. In order to decide whether a road improvement involving the elimination of steep gradients is an economical proposition, some reliable estimate of the fuel and the time likely to be saved as a result was thought to be necessary. In the approach used by the author, the engine output is equated to the resistance to motion at uniform speed conditions. The conclusions reached show that the fuel consumption for a journey between two points at the same altitude, on roads sloping at one in four, is nearly three times that for the same journey on the level. In addition, the journey takes three times as long. The paper also reveals the inherent inefficiency of the spark-ignition engine used, and arguments are advanced for the use of wider gear ratios and improved engine characteristics.

## ROYAL AGRICULTURAL SHOW, BLACKPOOL.

Fig. 5. Multi-Purpose Horticultural Tractor; Barford (Agricultural), Ltd.

# THE ROYAL AGRICULTURAL SHOW, BLACKPOOL.

(*Continued from page* 23.)

### Forage Harvester.

It is now generally accepted that a bruised or lacerated green crop makes better silage, and produces the end-product more rapidly than undamaged crops. The present tendency with green-crop or forage harvesters is, therefore, to design them so that the crop is lacerated as it is collected from the field. A good example of such a machine is furnished by the Silorator-Hayter harvester which is being shown by Silorators, Limited, 103, Park-street, London, W.1. This machine, which is illustrated in Fig. 7, on page 48, consists of a Silorator unit arranged to work in conjunction with two specially-designed horizontal cutters of the type developed by Messrs. Hayters, Limited, Spellbrook, Bishops Stortford. The Silorator unit was described in Engineering, vol. 168, page 639 (1949) in connection with that year's Royal Show. Its purpose is to lacerate the crop and it is designed so that the crop can subsequently be elevated and delivered, when used in the stationary role, to the silo or silage pit. In the case of the harvester, however, the lacerated, or "Silorated" crop is delivered into a trailer towed either alongside or behind the machine.

As will be seen from the illustration, the harvester is designed for towing behind a tractor and is driven from the tractor rear power take-off. It consists basically of a semi-rectangular channel frame mounted on two pneumatic-tyred wheels at the rear with a smaller, castoring wheel at the front, the mounting of which incorporates a height-adjustment box. The frame is designed to carry the Silorator, with its inlet and outlet ducting, the two Hayter cutters, and the driving gear. The cutters, as previously indicated, are disposed horizontally and each consists of a square plate to the corners of which are fitted short blades which sever the crop. The vertical spindles run in ball bearings and are driven by means of a belt. As the crop is severed by the Hayter cutters, which are contra-rotating, it is directed into the base of the inlet ducting, from which it is sucked by the Silorator unit, lacerated and subsequently delivered into the discharge ducting. The drive is transmitted from the tractor power take-off through a propeller-shaft fitted with Hardy-Spicer universal couplings to a speed-increasing unit having a ratio of 1 to 2. This drives the Hayter cutters through Brammer belting and at the same time provides the drive for the Silorator unit, but in the latter case the speed is increased again, the overall ratio being 1 to 3·76.

One of the chief features of the machine is its ability to deal with crops not suitable for the normal reciprocating cutter bar, such as over-lush soft strains of cocksfoot which have been laid. It can also be used without any alteration, apart from height adjustment, for picking up combined straw from the swath, disintegrating it and spreading it over the ground. Other uses to which it may be put include grain blowing, straw breaking and as a cutter-breaker-spreader of green manures for sheet composting.

### Elevating Crop Loader.

It is, of course, not always desirable to lacerate the crop as it is collected from the field. Hitherto, the traditional method of loading wagons or trailers by means of pitchforks has been employed in such cases, but this practice is rapidly dying out in favour of using elevator loaders which pick the crop from the ground and deliver it directly into the trailer. A new machine of this type, which is being shown by Bamfords, Limited, Uttoxeter, Staffordshire, the manufacturers, is illustrated in Fig. 8, on page 48. It has been designed primarily for use where considerable quantities of material either for silage-making or grass-drying have to be collected. As will be seen from the illustration, it is of the endless-conveyor type. It has an all-welded chassis frame mounted on, and driven from, pneumatic-tyred land wheels, a slipping over-load clutch being incorporated in the main drive to the actual conveyor. The loader has a pick-up width of 5 ft. and the delivery chute and elevator top are shielded to give protection of the crop from wind. To give a good performance when dealing with short crops, the tines fitted to the pick-up drum are spaced as closely as practicable and, to prevent clogging, they pass through a stripping device. The trailing wheels are arranged for castoring and their mountings incorporate height-adjusting boxes. Open chains are used to transmit the drive from the land wheels to the conveyor mechanism, which consists of a series of bars having short tines, the ends of the bars being secured to two endless chains.

### Twin-Cylinder 16-H.P. Diesel Engine.

The exhibits on Messrs. Bamfords' stand also include a selection from their extensive range of

# ROYAL AGRICULTURAL SHOW, BLACKPOOL.

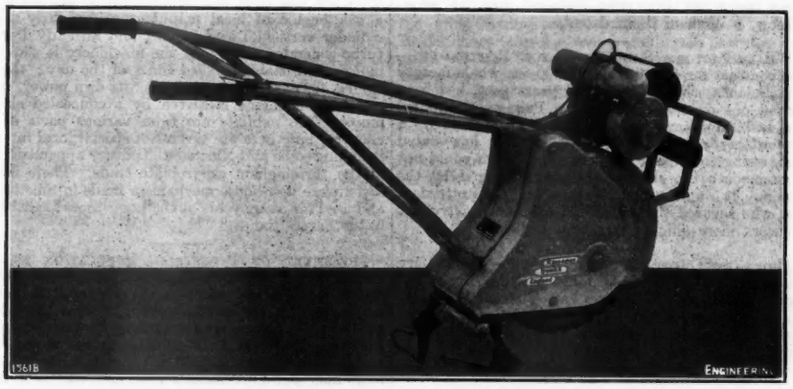

FIG. 6. POWER HOE; RANSOMES, SIMS AND JEFFERIES, LTD.

low-power Diesel engines. Three new models have recently been added to their Z series of direct-injection engines, namely: the Z2M of 5½ h.p.; the Z7 of 14 h.p.; and the Z8 of 16 h.p. The last-named unit is illustrated in Fig. 9, on page 48, from which it will be seen that it is a twin-cylinder engine of exceptionally clean design, parts fitted externally having been reduced to an absolute minimum. For ease of maintenance, and to reduce manufacturing costs, all the main components such as pistons, connecting rods, valves, etc., are the same as those used for the single-cylinder version of this range of engines. Outstanding features of the design are: the use of a hinged crankcase which allows the working parts to be inspected without having to disturb pipe connections, etc.; the use of a totally-enclosed governor unit which is installed in the cylinder block but can be removed without interfering with any other parts; an unusually simple valve arrangement, which consists of the minimum of moving parts; and the fitting of renewable cylinder liners. Pressure lubrication is employed for the main bearings and valve gear, but the big-ends are lubricated by splash. The rated output of 16 brake horse-power is developed at 700 r.p.m. and it will be appreciated that such a low speed makes it possible to use the engine for most farm duties without recourse to a speed-reduction unit.

### PIG-FOOD MINCING MACHINE.

Although a pig will eat almost anything, the best results are obtained if the feed is minced and mixed into a porridge-like consistency. This not only assists the animal's digestion but prevents him from nosing out the tit-bits and leaving the less-liked consituents, a process at which the pig is adept. Modern piggeries, therefore, use mincing machines to prepare the food and a good example of such a unit is provided by that being shown by Taskers of Andover (1932), Limited, Waterloo Iron Works, Andover, Hampshire. Two models of this machine are available, namely, a belt-driven unit and the electrically-driven unit illustrated in Figs. 10 and 11, on page 48. The former model is particularly suitable for use by pig farmers who are without electricity as it can be driven either from the belt-pulley power take-off of a standard tractor or from a stationary engine.

Apart from the motive power, however, both models are identical, consisting of a hopper having a capacity of approximately 20 gallons and constructed from heavy-gauge steel treated to withstand corrosion. The upper section is 2 ft. in diameter and is cylindrical for 9 in. downwards where the contraction begins, the diameter at the base being about 11 in. The knives, or cutters, are situated in the base, being fitted to an extension of the armature shaft in the case of the electrical machine and to an extension of the vertical pulley shaft in the case of the belt-driven unit. The cutters consist of two portions, each forming a pair of knives, one pair working horizontally and the other vertically. Both pairs work together, but the horizontal blades are shaped like a propeller so that, in addition to cutting the food, they exert a downward pull on the mixture, thus ensuring that all solid matter is drawn into the cutters. Baffles are provided to prevent a circular motion being set up within the bowl and a watertight gland is fitted round the vertical spindle to prevent seepage of the mixture; this gland is easily adjusted from within the hopper. When the feed is ready, the unit is tipped as shown in Fig. 11 for pouring off. This action automatically releases the driving tension in the final belt on the belt-driven model, thus giving the action of a clutch. As soon as the hopper is returned to, and locked in, the vertical position, the drive is taken up automatically and the tractor, or other prime mover, can thus be kept running throughout the process. The speed of the cutters is approximately 3,000 r.p.m. and, in the case of the electric model, they are driven by a 3-h.p. motor.

### TRACTOR-MOUNTED CARRIER BOX.

Taskers of Andover, Limited, are also showing a useful carrying attachment for use in conjunction with wheeled tractors. This unit, which is known as a front-mounted carrier box, is illustrated in Fig. 12, on page 48, where it is shown installed on an Allis-Chalmers light tractor. It is constructed mainly from 14-gauge sheet steel and consists of a platform with fixed back and dropping sides and front board, the three hinged boards being secured in either the upright position or vertically downwards by means of removable pins. In addition, the front may be supported horizontally by chains to form an extension of the platform. The carrier is supported by two channel-section members which, in turn, slide into two mating members bolted to the front of the tractor. These latter members can be left permanently on the tractor as they do not interfere with its operation or maintenance. The width of the box is 4 ft. 6 in. and the depth, 1 ft. 6 in. The height of the sides and front board is 1 ft. and the height of the back board, 1 ft. 9 in. This carrier is particularly useful as, being mounted at the front of the tractor, it does not interfere with any implement that may be installed at the rear; it can, therefore, be used for odd cartage jobs without having to remove the implement, which would be the case were a trailer used. Furthermore, when seeds are being drilled, extra supplies of the seed can be accommodated in the carrier and used as required, thus saving the necessity of returning to a central point each time the drill has to be filled.

### REAR-MOUNTED TRANSPORT PLATFORM.

A similar kind of device is being shown by Scottish Mechanical Light Industries, Limited, 42-44, Waggon-road, Ayre, Scotland, but in this case the carrier, which is referred to by the manufacturers as a transport platform, is fitted to the rear of the tractor. This unit is illustrated in Fig. 13, on page 48. It is of all-steel construction and can be fitted to any tractor provided with a hydraulic lift. As there is no need to remove the tractor pulley or alter the wheel setting, mounting of the platform occupies only a few moments. It will carry any weight within the capacity of the tractor and, due to its position, it can deal with loads having a greater width than that of the tractor. Clip-on sides and a front can be fitted to the platform, thus converting it into a transport box capable of accommodating six full milk churns.

### MULTI-PURPOSE HORTICULTURAL TRACTOR.

Since it was first introduced, considerable developments have been made to the Atom 15 horticultural tractor, and the latest model, which is being shown by the manufacturers, Barford (Agricultural), Limited, Grantham, Lincolnshire, is undoubtedly one of the most versatile tractors of its type available to-day. It is illustrated in Fig. 5, on page 44, where it is shown fitted with a reciprocating cutter bar, but the range of attachments available for use with this machine enables it to be used for such duties as lawn-mowing, hedge-trimming, spraying, ploughing, cultivating, harrowing and log sawing, to mention but a few. It can also be fitted with a trailer attachment capable of carrying a load of 7½ cwt. in addition to the driver, and a dump truck attachment with a capacity of 5 cwt., excluding the operator. It is, in fact, a very versatile machine and is as useful on a farm as on a market garden.

The power unit is a Villiers 1½-h.p. four-stroke petrol engine of the air-cooled type. The transmission system consists of a V-belt which is arranged to transmit the drive to a totally-enclosed reduction gearbox fitted with machine-cut gears operating within an oil-bath. There are two gear ratios, the lower of which gives a travelling speed of from ¾ miles an hour to 1½ miles an hour and the higher a speed of from 1½ miles an hour to 3 miles an hour. The frame is of rigid construction and is designed to carry tool bars at both the front and rear. The wheels are 20 in. in diameter and are fitted with differential hubs. Normally the tyres have traction treads, but grass tyres are available if required. The wheel track on the standard model is adjustable between the limits of 21 in. and 14 in. but an alternative axle permits a working width of 27 in. The work which the machine is capable of handling can, perhaps, best be illustrated by referring to its ploughing propensities: in a medium soil it will plough to a depth of approximately 6 in. with a furrow width of 5 in. to 6 in.

### POWER HOE.

An unusual type of small power implement is being shown by Ransomes, Sims and Jefferies, Limited, Orwell Works, Ipswich. This implement, which is known as the Vibro-Hoe, is illustrated in Fig. 6, on this page. It has been designed to reproduce the action of hand hoeing, and to achieve this it is fitted with reciprocating blades that move backwards and forwards through a small arc at a speed directly proportional to the rate of travel. This reciprocating motion automatically frees the blades of matted weeds and roots and eliminates, therefore, stoppages due to clogging. Furthermore, it enables the hoe to work close up to rows without spilling soil over the growing plants. A length of chain is attached to each blade, the purpose of which is to assist in pulverisation and agitate the severed weeds so that they are shaken free of soil, thus ensuring rapid withering. Other advantages claimed for the Vibro-Hoe include positive penetration of the soil in conditions not ordinarily suitable for standard-type hoes and the production of a better tilth as the "stirring" effect is much greater than with fixed blades. The machine is powered by a Villiers two-stroke petrol engine having a capacity of 98 cub. cm. and the transmission group includes an automatic clutch, thus enabling control to be achieved by a single lever. The Vibro-Hoe, it should be added, has been patented jointly by Messrs. Ransomes, Sims and Jefferies and Mr. Wallace Henderson, who has designed several new implements and was instrumental in perfecting this machine.

*(To be continued.)*

# NOTES FROM THE INDUSTRIAL CENTRES.

## SCOTLAND.

PRODUCTIVITY COMMITTEE FORMED IN EDINBURGH.—An Edinburgh productivity committee was formed on June 30 at a special meeting of the Scottish Board for Industry. The chairman is Mr. P. J. W. Kilpatrick, of T. & A. Constable, Ltd., and the honorary secretary is Mr. W. V. Stevens, secretary of the Edinburgh Chamber of Commerce.

FLOODING OF GLASGOW UNDERGROUND RAILWAY.—Trains resumed running on the Glasgow Underground Railway on June 30 after it had been out of action since June 26, when a heavy rainstorm caused flooding which overwhelmed the pumping plant. The interruption to services was the longest since the war, when the service was interrupted for a week by bomb damage.

FILM ON SHIPBUILDING.—"The Building of a Ship," a colour film produced by W. Ralston, Ltd., and Elder Film Productions, Ltd., Glasgow, and shown in the Engineering Centre, Glasgow, on June 30, portrays the construction by the Blythswood Shipbuilding Co., Ltd., Glasgow, of the motor tanker Harold Sleigh for H. C. Sleigh, Ltd., Melbourne. It records the progress of the vessel from the drawing board to handing over after trials, and the scenes include the fitting of the propeller and the installation, in difficult weather conditions, of the engine bedplate.

SHORTAGE OF WATER IN AIRDRIE AND COATBRIDGE.—Appeals have been made in the Airdrie, Coatbridge, and surrounding districts for economy in the use of water to prevent unemployment through works having to close down. The supply position has been described as the worst for the past 100 years. Supplies have been reduced since June 29, and by this means the Water Board hope to save about one-fifth of their daily consumption of 1,000,000 gallons.

CANCELLATION OF SHIPBUILDING CONTRACTS.—The Pacific Steam Navigation Company have cancelled their contract with the Greenock Dockyard Company for the cargo-passenger turbine steamer Pizarro, of 8,400 tons gross. The cancellation means a loss of work also for John G. Kincaid & Co., who were constructing the propelling machinery. Port Glasgow and Greenock firms have now lost orders for four ships, and East of Scotland firms have also had four cancelled.

THE LATE MR. W. DAWSON.—Mr. W. Dawson, B.Sc., director of Dawson & Downie, Ltd., engineers and pump-makers, Clydebank, died on June 27 from injuries sustained in a road accident. He graduated in naval architecture at the University of Glasgow, where, for a time, he was an assistant to the late Professor Sir John Biles in the department of naval architecture.

## CLEVELAND AND THE NORTHERN COUNTIES.

PUBLICITY COMMITTEE FOR THE NORTH-EAST.—A number of prominent men, including industrialists and trade-union officials in the North-East, have been invited by the North-East Development Association to join an advisory committee to make their district better known. The Association, in a statement, points out that the North-East is a sort of "no man's land" between England and Scotland and that many people have only a vague idea, usually an unfavourable one, of the area and what it produces.

CHANGES IN A SHIPBUILDING ORDER.—An order placed with Swan, Hunter, and Wigham Richardson, Ltd., Wallsend, about 18 months ago, for a 10,000-ton dry cargo ship, and later changed for a tanker of 18,000 tons, has now been changed back again to the original order for a 10,000-ton cargo ship. The ship was ordered for a Panama company.

SHIPBUILDING ACTIVITY ON THE TYNE.—Five ships (three tankers, a cargo ship and a cargo liner) representing 50,000 gross tons are due for launching on the Tyne during July, and all the Tyne yards, with the exception of R. & W. Hawthorn, Leslie & Co., Hebburn, will participate. These launches will bring the Tyne's output for the seven months of this year to 17 vessels aggregating 158,000 gross tons, compared with 15 vessels totalling 92,000 tons last year. On July 9, Clelands (Successors), Ltd., will launch a 490-ton tanker. On the following day, John Readhead & Sons, South Shields, will launch a 7,400-ton cargo ship, and Swan, Hunter and Wigham Richardson, Ltd., will have a 12,000-ton Norwegian tanker ready for the water. Vickers-Armstrongs Ltd., Walker, will launch a 7,800-ton cargo liner for Holt and Co. on July 22, and, on July 24, the 22,000 gross tons (32,000-tons deadweight) tanker British Merchant will enter the water from the Wallsend yard of Swan, Hunter, & Wigham Richardson.

WHALE-FACTORY SHIP REFIT FOR ROTTERDAM.—The contract for refitting the 15,800-ton whale-factory ship Balaena which, for several years past, has been carried out on the Tyne by the Palmers (Hebburn) Co., Ltd., Hebburn, has this year been secured by a Rotterdam firm. An official of Palmers has stated that, owing to other commitments, his firm could not accommodate the ship at the time required by the owners. It is understood, however, that the Rotterdam firm who secured the order had offered to carry out the work more quickly than any British firm.

THORNABY MOTIVE-POWER DEPOT.—Preliminary site work has commenced for a new motive-power depot for British Railways at Thornaby-on-Tees. The preparation of the site is being carried out by Messrs. Leonard Fairclough, of Adlington, Lancashire, and will take about three months.

## LANCASHIRE AND SOUTH YORKSHIRE.

WOODHEAD TUNNEL.—The new Woodhead tunnel, completed for British Railways at a cost of 5,000,000*l*., will be handed over in five weeks' time. More than three-quarters of its 3 miles and 66 yards through the Pennines traverses treacherous rock which had to be supported. The rock was so hard that it had to be blasted, but after a few days' exposure to the air it crumbled and sometimes collapsed. Track-laying and electrification will take six months, and the first electric train between Manchester and Sheffield is not expected to pass through until early 1954.

MANUFACTURE OF SPUN-IRON PIPES.—Stanton Iron Works Co., Ltd., have planned to work double shifts to increase the production of spun-iron pipes, which are in such short supply that major projects of the East Midlands Gas Board are held up. A minimum of 200 extra men is needed to carry out the expansion of output. Officials of the company have recruited 50 men in Ireland.

FLUORINE POISONING.—It is suggested that some compensation should be paid to farmers whose stock is affected by fluorine poisoning in the neighbourhood of iron and steel works. Mr. H. T. Jones, provincial director of the National Agricultural Advisory Service, states that fluorine poisoning is far more serious in the Rotherham area than in any other part of England. The West Riding County Agricultural Officer, Mr. J. Gibbons, states that fluorine occurs as a surface deposit on plants. Crops are not seriously affected, but grazing animals suffer.

THE LATE MR. W. KELLETT.—Mr. Walter Kellett, of 228, Abbey Lane, Sheffield, founder of W. Kellett & Co., Ltd., engineers, 653, Attercliffe-road, Sheffield, died on June 29, at the age of 71.

## THE MIDLANDS.

LARGE STILL FOR NEW REFINERY.—A 30-ton tube still for a recovered-oil distillation unit at the new Anglo-Iranian refinery on the Isle of Grain has been manufactured by Weldall and Assembly, Ltd, Stourbridge, Worcestershire, a member of the Triplex group of companies. The unit has a total height of 121 ft. 6 in. and consists of a main body, 43 ft. high and 12 ft. 5 in. in diameter, with a platform fitted round the top, making a total diameter of 20 ft. 6 in. Inside the main body is a $\frac{1}{4}$ in. thick stainless-steel cone through which pass 40 steel tubes. The entire unit was conveyed to the Isle of Grain from the Stourbridge works by road—a journey of four days.

"SEA HAWK" HANDED OVER TO ROYAL NAVY.—The first of the European fighter aircraft ordered under the American off-shore procurement programme was handed over to the Royal Navy on June 26. The plane was a Hawker Sea Hawk naval jet fighter, 107 of which were bought from the Hawker-Siddeley Group of aircraft manufacturing companies under the 281,000,000 dols. N.A.T.O. contract signed in Paris last April. The production of Sea Hawks has now been taken over from Hawker Aircraft by Sir W. G. Armstrong Whitworth Aircraft, Limited. This first N.A.T.O. Sea Hawk carried out its initial flight only three days before the hand-over, and delivery was made at Armstrong Whitworth's Bitteswell airfield.

ENGINEERING HALL AT BIRMINGHAM MUSEUM.—A further extension to the Museum of Science and Industry, Newhall-street, Birmingham, 3, was opened by the Lord Mayor of Birmingham, Alderman G. H. W. Griffith, J.P., on June 19. It is the Museum's first collection of heavy exhibits to be placed on public exhibition. The emphasis is on prime movers, and there are examples of steam engines of various types, a gas engine of local manufacture, an early single-cylinder vertical Diesel engine, and an early Parsons turbo-generator. Some of the machinery is shown in motion at certain specified times of the day; the gas engine, for example, is run under its own power, and a small beam engine is driven by a concealed electric motor. The exhibits are from various parts of the country, but there are several of special local interest, including some mid-Nineteenth Century apparatus used in the Birmingham electroplate trade. There is also a complete lighthouse mechanism made in Smethwick, and used for many years at the Longstones Lighthouse, in the Farne Islands.

MOVEMENT OF INDUSTRIAL POPULATION IN THE MIDLANDS.—Figures issued by the Ministry of Labour and National Service show that the migration of industrial population to the Midlands is greater than in any other part of the country, except London and the south-east. An analysis of employment figures estimates that between May, 1951, and May, 1952, 5,000 more men and 4,000 more women entered the Midland region to take up employment than left it to work in other regions.

ROADS IN STAFFORDSHIRE.—The newly appointed chairman of the Staffordshire County Council, Alderman W. Nevill, who was for the previous seven years chairman of the Council Roads and Bridges Committee, has issued a statement concerning the county roads. He says that the County is responsible for the maintenance of 122·83 miles of trunk roads, and 243·83 miles of Class 1 roads. On the former, 97 miles allow for only two traffic lanes, and on the latter the figure is 240·72 miles. The trunk roads carried about 122,000 tons a day in 1938, but the daily load had increased to 176,000 tons by 1950. Abnormal loads have also increased; last year the monthly average was 519.

SEARCH FOR AN OLD MOTOR CAR.—Mr. Sidney Guy, chairman of Guy Motors Ltd., Fallings Park, Wolverhampton, is trying to obtain a Guy V-8 motor car, which was placed on the market by his company in 1919. The Guy V-8, which on the old R.A.C. basis was rated at 20 h.p., had an engine which was carried on a sub-frame suspended by three spherical joints, and thus anticipated, in some degree, the modern method of flexible mounting.

## SOUTH-WEST ENGLAND AND SOUTH WALES.

ADMIRALTY CONTRACTS IN SOUTH WALES.—The Admiralty have spent more than 2,489,330*l*. in the South Wales ports on the refit of Royal Navy vessels since 1949, the Welsh Board for Industry were told at their meeting last week. Substantial contracts continued to be placed with Welsh firms, including orders for inflatable rafts, aluminium-alloy sheets, plating, chains and chain-cable gear, and special alloy valves. Admiralty expenditure on direct contracts with industry in Wales, during the last four years, has totalled about 6,930,000*l*.

THE POSITION OF THE SEVERN BARRAGE.—An economic case for embarking on a Severn barrage project has not been established at present, Mr. Geoffrey Lloyd, Minister of Fuel and Power, has said in Parliament. Research, he continued, was in hand on various unsolved technical problems, and experiments were being made on models to determine the effect of the barrage on the Bristol Channel ports. According to Mr. Gerald Nabarro, who took part in the debate, the scheme, at a very modest estimate, would cost 200,000,000*l* and would save 1,000,000 tons of coal a year. In his opinion, vastly greater fuel economies could be made in other directions.

TRADE OF SOUTH-WALES PORTS.—The South Wales ports, in the period January 1 to June 14 this year, dealt with a total of 9,940,430 tons of trade, a reduction of 406,325 tons when compared with the corresponding period of 1952. A feature of the returns issued by the Docks and Inland Waterways Executive was the activity reflected at Port Talbot, where the total trade increased from 611,812 tons, a year ago, to 888,397 tons this year. The expansion in the iron and steel industry was largely responsible, imports of iron ore rising from 391,691 tons to 613,558 tons, while iron and steel goods exported rose from nil, a year ago, to 14,767 tons in 1953.

CARMARTHEN BAY POWER STATION.—The first turbo-alternator installed at the new power station at Carmarthen Bay was put into operation recently. The set, rated at 52·5 MW, is to be followed by a similar set and four 60-MW sets. This will bring the total capacity of the station up to 345 MW.

## LAUNCHES AND TRIAL TRIPS.

M.S. "DUNNET HEAD."—Single-screw cargo vessel, built by Henry Robb, Ltd., Leith, to the order of A. F. Henry & MacGregor, Ltd., Leith. Main dimensions: 180 ft. between perpendiculars by 31 ft. by 15 ft.; deadweight capacity, 900 tons on a draught of about 13 ft. 3 in. Four-cylinder Diesel engine, developing 640 b.h.p. at 250 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Speed, 10¾ knots, fully loaded. Trial trips, June 21 to 24.

S.S. "ALDEBARAN."—Single-screw dredger, built and engined by Chantiers et Ateliers Augustin Normand, Le Havre, France, for the French Navy. Main dimensions: 151 ft. 11 in. by 27 ft. 11 in. by 7 ft. 6 in.; displacement, 424 tons. Double-reduction geared gas turbine, developing 1,800 h.p. Speed, 15 knots. Launch, June 27.

H.M.S. "BEACHAMPTON."—Coastal minesweeper, built by the Goole Shipbuilding and Repairing Co., Ltd., Goole, for the Royal Navy. Length, 152 ft.; beam, 28 ft. 9 in.; with an armament of three small guns. Admiralty standard Diesel engines, constructed by Mirrlees, Bickerton and Day, Ltd., Stockport, Cheshire. Launch, June 29.

S.S. "CALTEX PERTH."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for Overseas Tankship (U.K.), Ltd., London, W.1. Second of two vessels for these owners. Main dimensions: 515 ft. between perpendiculars by 70 ft. by 39 ft. 9 in.; deadweight capacity, about 17,400 tons on a summer draught of 30 ft. 4¾ in.; oil-carrying capacity, 16,140 tons. Double-reduction geared steam turbines, developing 7,300 s.h.p. at 100 r.p.m. in service, constructed by Richardsons, Westgarth & Co., Ltd., Wallend-on-Tyne; and two Foster Wheeler oil-burning boilers. Speed, 15 knots. Launch, June 29.

M.S. "BRITISH ENVOY."—Single-screw oil tanker built and engined by William Doxford and Sons, Ltd., Sunderland, for the British Tanker Co., Ltd., London, E.C.2. Main dimensions: 515 ft. by 69 ft. 6 in. by 37 ft. 6 in.; deadweight capacity, 16,000 tons on a draught of 30 ft. Doxford six-cylinder opposed-piston oil engine, developing approximately 6,450 b.h.p. at 117 r.p.m., and a speed of about 14 knots. Launch, June 29.

S.S. "LORD ALEXANDER."—Single-screw trawler, built by Cochrane & Sons, Ltd., Selby, Yorkshire, for the Lord Line Limited (Associated Fisheries Trawling Co., Ltd.), Hull. Main dimensions: 180 ft. between perpendiculars by 32 ft. by 16 ft. 6 in.; gross tonnage 750. Triple-expansion steam engine, developing 1,150 i.h.p. and one oil-burning boiler, constructed by Charles D. Holmes & Co., Ltd., Hull. Speed, about 13¾ knots. Launch, June 29.

M.S. "FLEETBANK."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for the Andrew Weir Shipping and Trading Co., Ltd., London, E.C.3. Third vessel of a series of six for these owners. Main dimensions: 425 ft. between perpendiculars by 59 ft. by 38 ft. 3 in. to shelter deck; gross tonnage, about 5,800. Harland-B. and W. six-cylinder two-stroke single-acting opposed-piston Diesel engine. Launch, June 29.

S.S. "HAUSTRUM."—Single-screw oil tanker, built and engined by R. and W. Hawthorn, Leslie & Co., Ltd., Hebburn-on-Tyne, County Durham, for the Anglo-Saxon Petroleum Co., Ltd., London, E.C.3. Main dimensions: 557 ft. overall by 69 ft. 3 in. by 39 ft. to upper deck; deadweight capacity, about 18,000 tons. Double-reduction geared steam turbines, developing a maximum of 8,250 s.h.p., and two Foster Wheeler water-tube boilers. Speed, about 15 knots. Launch, June 29.

M.S. "LA CHACRA."—Single-screw cargo vessel, built by Bartram and Sons, Ltd., Sunderland, for Buries Markes, Ltd., London, E.C.3. Main dimensions: 440 ft. between perpendiculars by 60 ft. 6 in. by 38 ft. 4 in. to shelter deck; deadweight capacity, 9,500 tons on a summer draught of 26 ft. 0½ in. N.E.M.-Doxford five-cylinder two-stroke opposed-piston oil engine, developing 5,500 b.h.p. at 115 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Service speed, 14½ knots. Launch, June 29.

M.S. "ROYALGATE."—Single-screw cargo vessel, built by the Goole Shipbuilding and Repairing Co., Ltd., Goole, for the Hulligates Shipping Co., Ltd., Hull. Main dimensions: 175 ft. by 27 ft. 6 in. by 11 ft. 6 in.; deadweight capacity, 700 tons. Seven-cylinder Diesel engine, developing 545 b.h.p. at 300 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Launch, June 30.

M.S. "FAIRTRY."—Single-screw factory trawler, equipped for the quick freezing of catches of fish. Built and engined by John Lewis & Sons, Ltd., Aberdeen, for Chr. Salvesen & Co., Leith. Main dimensions: 245 ft. between perpendiculars by 44 ft. by 24 ft. to main deck. Lewis-Doxford four-cylinder opposed-piston oil engine, developing 1,900 b.h.p. at 135 r.p.m. Launch, June 30.

## CONTRACTS.

BRITISH INSULATED CALLENDER'S CABLES, LTD., have been awarded the contract for the sea trials in the cross-Channel cable project announced by the British Electricity Authority, and details of which were given on page 31, *ante*. The firm is working in the closest collaboration with W. T. GLOVER & CO., LTD., whose design of 132-kV gas-filled cable has been chosen for the contract. The associated cable accessories have been designed by British Insulated Callender's Cables and the whole of the installation work will be carried out by the BRITISH INSULATED CALLENDER'S CONSTRUCTION CO., LTD.

BRUSH BAGNALL TRACTION, LTD., have received an order from the Steel Company of Wales, Ltd., for seven 300-h.p., 0-4-0, and three 515-h.p. BO-BO Diesel-electric locomotives. This brings the total number of locomotives ordered by the Steel Company of Wales from Brush Bagnall to 17. All the locomotives have been specially designed for heavy steelworks operation. The electrical equipments are provided by the BRUSH ELECTRICAL ENGINEERING CO., LTD., the Diesel engines by MIRRLEES, BICKERTON AND DAY, LTD., and the NATIONAL GAS AND OIL ENGINE CO., LTD., and the mechanical parts by W. G. BAGNALL, LTD., Stafford.

MARCONI'S WIRELESS TELEGRAPH CO., LTD., Chelmsford, Essex, are supplying all the equipment in connection with a contract worth more than 250,000*l*. for a high-frequency intercommunications system for the Government of Burma. The system will link 12 main centres, including Rangoon, by both radio telephone and telegraph, and each centre will be connected with a large number of satellite towns by radio telegraph. The telephone and telegraph links are to operate as entirely independent services with separate transmitters, receivers and auxiliary equipment on each link. The latter vary in length from 95 to 588 miles. Transmitters of 100-W and 200-W power will be used on the telegraph links and transmitters of 500-W on the telephone links.

During June, the British Electricity Authority have placed contracts for equipment for power stations and transforming stations, amounting, in the aggregate, to 7,816,110*l*. The principal contracts include: for Acton-lane "B" Power station, Willesden, one 30,000-kW turbo-generator, feed-water heating and condensing plant, and auxiliary apparatus, with RICHARDSONS, WESTGARTH & CO., LTD.; for Brunswick Wharf power station, Poplar, generator and unit transformers, with the METROPOLITAN-VICKERS ELECTRICAL CO., LTD.; for Deptford East power station, one 250,000 lb. per hour boiler and auxiliary equipment, with FOSTER, WHEELER, LTD., one 52,500-kW turbo-generator and auxiliary apparatus, with the METROPOLITAN-VICKERS ELECTRICAL CO., LTD., and condensing and feed-heating plant for one 52,500-kW turbo-generator set, with VICKERS-ARMSTRONGS LTD.; for Hackney power station, reinforced-concrete framework for a precipitator house and cooling tower, with J. L. KIER & CO., LTD.; for Brighton "B" power station, one 60,000-kW turbo-generator set and condensing and feed-heating plant, with RICHARDSONS, WESTGARTH (HARTLEPOOL), LTD.; for Marchwood power station, near Southampton, five 60,000-kW turbo-generators, with the ENGLISH ELECTRIC CO., LTD.; for Portishead "B" power station, near Bristol, one 60,000-kW turbo-generator, condensing and feed-heating plant and generator and unit transformers, with the METROPOLITAN-VICKERS ELECTRICAL CO., LTD.; for Ince power station, near Ellesmere Port, one 60,000-kW turbo-generator, with the GENERAL ELECTRIC CO., LTD.; and condensing and feed-heating plant for one 60,000-kW turbo-generator, with HICK, HARGREAVES & CO., LTD.; for Thornhill power station, near Dewsbury, Yorkshire, a cooling tower, with J. L. KIER & CO., Ltd.; for Chadderton power station, Oldham, the foundations and superstructure, with FRED MITCHELL & SON, LTD.; for Barony power station, Ayr, two 30,000-kW turbo-generators, with the GENERAL ELECTRIC CO., LTD., and condensing and feed-heating plant for two 30,000-kW turbo-generators, with HICK, HARGREAVES & CO., LTD.; and for Castle Donington, near Derby, 132-kV 3,500-MVA switchgear, with the BRITISH THOMSON-HOUSTON CO., LTD.

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THE LATE MR. A. F. BOCK.—We regret to record the death of Mr. Arthur F. Bock, which occurred at Sutton Coldfield on Sunday, June 21. He served his apprenticeship with Westinghouse Electrical and Manufacturing Co., Ltd., at Trafford Park and joined the Plant Department of the firm in 1910. During the 1914-18 war he attained the rank of captain and, after returning to the Plant Department for a short time, represented the Metropolitan-Vickers Electrical Co. Ltd. in Chile and Peru. He was appointed manager of the same Company's Birmingham office in 1926, a position he held until his retirement in October 1952.

## PERSONAL.

Vickers Ltd., Vickers House, Broadway, London, S.W.1, announce that MAJOR SIR HEW KILNER, M.C., has relinquished his seats on the board of the parent company and its subsidiaries, owing to continued ill-health. Following this, MAJOR-GENERAL C. A. L. DUNPHIE, C.B., C.B.E., D.S.O., has been made deputy chairman and managing director of Vickers-Armstrongs Ltd., as from July 1; MR. P. H. MUIRHEAD, C.B.E., has been appointed managing director, and MR. F. P. LAURENS, O.B.E., M.I.Mech.E., deputy managing director, Engineering Division, and MR. G. H. HOULDEN, M.B.E., managing director, Shipbuilding Division. MR. R. P. H. YAPP has been appointed chairman of Cooke, Troughton and Simms Ltd.

MR. HUGH MCC. JACK, B.Sc., relinquished his executive duties as chief electrical engineer of the British Thomson-Houston Co. Ltd., Rugby, on June 30, but retains his directorship. His successor is his chief assistant, MR. G. S. C. LUCAS, O.B.E., M.I.E.E.

DR. WILLIS JACKSON, M.I.E.E., F.R.S., has now taken up the position of director of research and education to the Metropolitan-Vickers Electrical Co. Ltd., and has joined the board of the company.

MR. E. D. E. ANDREWES, a director of Tube Investments Ltd., The Adelphi, London, W.C.2, has been appointed joint managing director of Accles and Pollock Ltd., Oldbury, a member of the TI Group.

The Summerson Group of Companies announce that MR. ROLAND WINN has been appointed a director of Thomas Summerson and Sons, Ltd., that MR. A. F. TOSH is to be a director of Summerson's Foundries Ltd., that MR. C. WHITEHOUSE has been elected a director of Copelaw Engineering Co. Ltd., and that MR. G. V. NEWLANDS has joined Thomas Summerson and Sons, Ltd., as works engineer, on the retirement of MR. WALTER SCOTT.

MR. GEORGE HILTON, shipbuilding manager, and MR. J. R. DUNCAN, engineering manager of Scotts' Shipbuilding and Engineering Co., Ltd., Greenock, have been appointed directors of the company.

MR. A. W. G. TRANTOR, previously works manager of the Kent oil refinery of the Anglo-Iranian Oil Co., Ltd., on the Isle of Grain, has been appointed general manager of the Aden Refinery. His successor at the Kent refinery is MR. A. PATRICKSON.

MR. M. H. C. GORDON, who recently resigned his position as chief maintenance engineer to the British European Airways Corporation, is to take up an appointment as general manager, Helicopter Division, Saunders-Roe Ltd., Eastleigh, Hampshire, on July 13.

MR. J. R. C. JOHNSON has been appointed manager, Contracts Division, the Marconi International Marine Communication Co., Ltd., Chelmsford, Essex.

MR. F. S. NAYLOR, B.Sc.(Eng.), A.C.G.I., M.I.E.E., who has been an assistant commercial manager of the British Electricity Authority for the past five years, has been appointed specifications and contracts engineer in the chief engineer's department of the Authority.

MR. J. MAXWELL LAING, B.Sc., A.M.I.Mech.E., has relinquished the appointment of export-sales director, Turner Manufacturing Co. Ltd., Wolverhampton, to take up that of general sales manager, Audley Engineering Co. Ltd., Newport, Salop.

MR. F. L. HARRAP has been appointed export-sales director and MR. G. S. SUTCLIFFE, home-sales director of Ferodo Ltd., Chapel-en-le-Frith. MR. S. C. CLIFFORD has joined the board as works director.

MR. CYRIL ANDERTON, M.I.Ex., has joined Clifford Aero and Auto Ltd., as general sales manager, Agricultural Division.

MR. HERBERT MCWHINNIE, J.P., retired from the position of general sales manager of the Steel, Peech and Tozer Branch of the United Steel Companies Ltd., Sheffield, on June 30, but will remain in an advisory capacity for a period.

MR. PAUL THOMSON has been appointed technical publicity adviser to *Look and Listen*, a journal of audio-visual aids in education, 45, Dorset-street, London, W.1.

MR. F. J. THOMPSON has been appointed commercial manager to the Express Lift Co. Ltd., in succession to the late MR. A. E. HUNT.

MR. H. C. W. TRAFMORE, M.I.P.E., has relinquished the post of chief production engineer to Blackburn and General Aircraft Ltd., to take up that of production manager to Boulton Paul Aircraft Ltd.

SIMMONDS AEROCESSORIES LTD., Treforest, Glamorgan, inform us that reorganisations have taken place in the FIRTH CLEVELAND GROUP, and that the name of one of their companies, WHATTON AND SONS, has now been changed to FIRTH CLEVELAND (MACHINE TOOLS) LTD., 149, Merridale-street West, Wolverhampton.

# EXHIBITS AT THE ROYAL AGRICULTURAL SHOW, BLACKPOOL.

(*For Description, see Page* 44.)

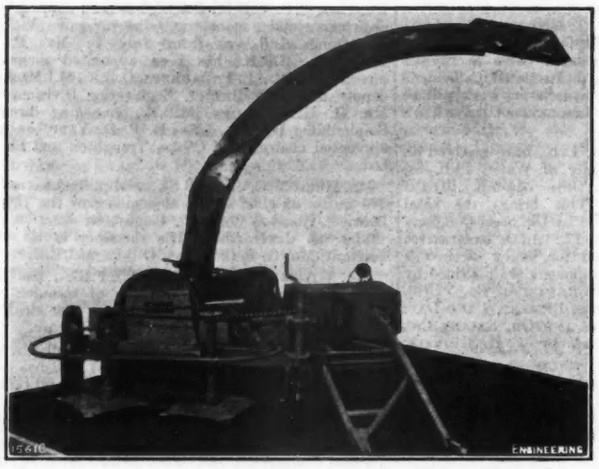


FIG. 7. FORAGE HARVESTER; SILORATORS, LTD.

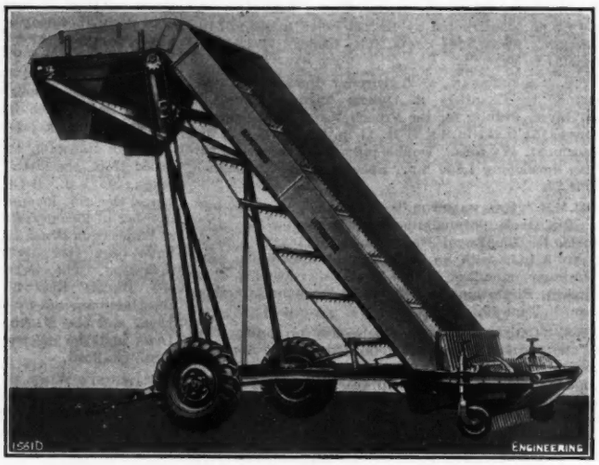


FIG. 8. ELEVATING CROP LOADER; BAMFORDS, LTD.

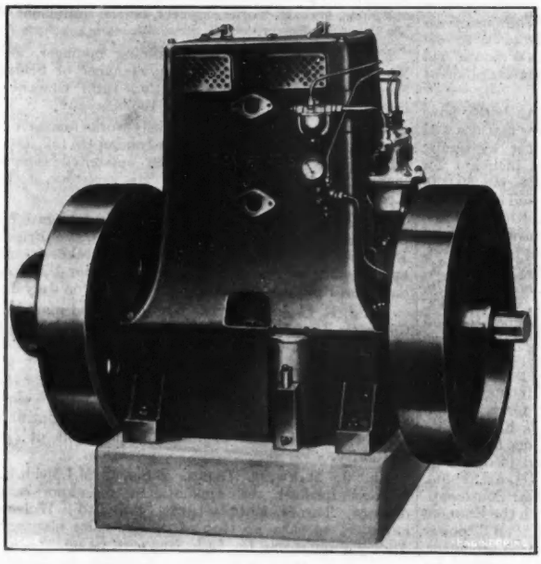

FIG. 9. TWIN-CYLINDER 16-H.P. DIESEL ENGINE; BAMFORDS, LTD.

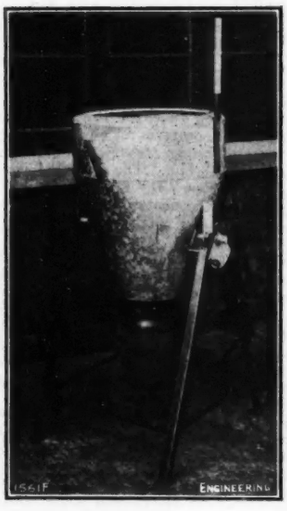


FIG. 10.

FIG. 11.

FIGS. 10 AND 11. ELECTRICALLY-DRIVEN PIG-FOOD MINCING MACHINE; TASKERS OF ANDOVER (1932), LTD.

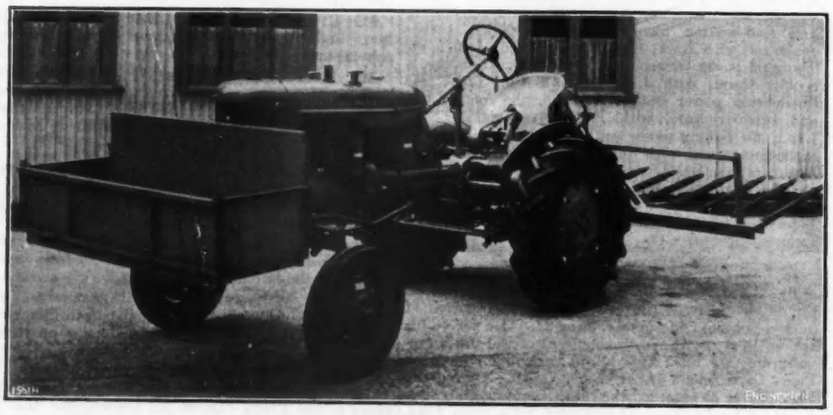

FIG. 12. TRACTOR-MOUNTED CARRIER BOX; TASKERS OF ANDOVER (1932), LTD.

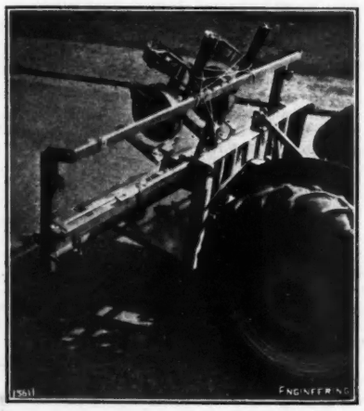

FIG. 13. REAR-MOUNTED TRANSPORT PLATFORM; SCOTTISH MECHANICAL LIGHT INDUSTRIES, LTD.

# ENGINEERING.

35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

*Registered at the General Post Office as a Newspaper.*

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and any other publication bearing a similar title.

*Telegraphic Address:*
ENGINEERING, LESQUARE, LONDON.

*Telephone Numbers:*
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|---|---|
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| For Canada | £5 5 0 |

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## ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

## TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Monday.

"Copy" instructions and alterations to standing advertisements for display announcements must be received 16 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.


**INDEX TO VOL. 174.**

**The Index to Vol. 174 of ENGINEERING (July-December, 1952) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher. In order to reduce the consumption of paper, copies of the Index are being distributed only in response to such applications.**

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# ENGINEERING

*FRIDAY JULY* 10, 1953.

VOL. 176. No. 4563.


## THE COST OF AUTOMATIC TRAIN CONTROL.

THE possible achievements of engineering are, if not limitless, at least unknown. Given the money and the time, there is no knowing what it can do. But money and time are rationed commodities and some sense of proportion must be preserved in allotting them. The Chief Inspecting Officer of Railways, in his report on the terrible double collision at Harrow last October, has stated that no financial considerations should be allowed to stand in the way of an ambitious programme of automatic train control, and the British Transport Commission have informed the Minister of Transport that they will be prepared at once to consider financial authority for a practical programme of installation. A five-year plan to equip 1,332 route miles on some of the principal main lines will cost an estimated 7,500,000*l.*, or a long-term plan covering an additional 3,988 route miles will cost 17,300,000*l.* The corresponding annual charges are estimated at 1,000,000*l.* and 2,200,000*l.*

No one who is conscious of the tragedy of the Harrow accident (Colonel Wilson's report conveys a profound sense of tragedy) will under-estimate the dire effects of that calamity on countless men, women and children. The driver of the Perth express, who, it can only be assumed, momentarily relaxed his attention to signals, was a steady, even-tempered man and a good driver, who showed a keen interest in his work and was in the habit of attending improvement classes in his spare time. In the shifting mists of the morning of October 8, his 525-ton train bore down from the north on the packed local train standing in Harrow and Wealdstone station. The "Obstruction Danger" signal was sent out by the signalman, but it was too late to stop a Euston-Liverpool express. The first collision was followed almost immediately by a second, and the final death roll numbered 112. If the Liverpool express had not been five minutes late leaving Euston due to a minor defect—but there are no grounds for recrimination: the delay might equally have had the effect of avoiding a second collision.

Public feeling, very naturally, demands that no effort should be spared in taking steps to prevent a recurrence, but a decision as to which of the two automatic train-control plans is to be adopted must be reached with reasonableness, however difficult that is while the memory of October 8 is still widespread and fresh. From 1912 to 1952, in railway accidents which were the subject of Government inquiries, 399 out of the total of 1,416 fatalities might have been prevented or mitigated by warning control. There are insufficient data in the report to show what proportion of the 399 fatalities occurred on the lines included in the proposed five-year and long-term plans, though the long-term plan would cover about 35 per cent. of the total route mileage. An accident at Norton Fitzwarren in 1940, in which 27 persons were killed, should have been prevented by warning control, which was provided, but the driver failed to avail himself of its assistance. These considerations must clearly be borne in mind, and set beside the estimated costs of the alternative plans. A wider view must also recognise the insistent demands for road safety. The British Road Federation have conducted a long campaign for greater expenditure on roads, but however right their arguments have been they have, perhaps, suffered from the disadvantage that they represent the views of road interests. Now, however, the Federation of British Industries—who are as nearly representative of the country's true interests as any trade association can be—have broken their silence on the subject by submitting a memorandum to the Chancellor of the Exchequer directing his attention to the urgent need for a programme of development for the trunk roads, covering both improvement and construction. The Federation are convinced, from the day-to-day experience of their large industrial membership, that a start must be made now. Commenting on this memorandum, the British Road Federation remark that more people are killed on the inadequate roads of Great Britain every ten days than were killed in the Harrow railway accident, yet only 3,200,000*l.* is being spent on the road "blackspots," and 70 per cent. of the value of all goods moved is borne by road transport. These are unpleasant facts to have to face so soon after the publication of the Harrow accident report. The Minister of Transport has authority over roads and railways alike, but no doubt he will be guided by debates in Parliament in reaching a decision and issuing instructions.

Colonel Wilson does not regard automatic train control as a competitor with other signalling developments, but as complementary to them. The Railway Executive, also, recommended in 1948 a more extensive programme than that now proposed. The British Transport Commission, however, have emphasised that, while automatic train control deserves high priority among safety measures, it cannot be given absolute priority over other forms of signalling modernisation, such as the extension of track-circuiting and block controls to prevent mistakes by signalmen. "The safety of railway operation," Colonel Wilson says, "depends on many factors, and besides modern signalling equipment they include a good track and soundly constructed and maintained rolling stock. The provision of automatic train control is only one of them, and the proportion of accidents which it can

prevent is comparatively small, but they are of a type which can be disastrous to life and very costly to the administration, and therein lies its special value as a safeguard against the consequences of human failure." This is as far as Colonel Wilson goes in admitting any possible lack of resolution regarding the amount by which automatic train control should be extended. The main part of his remarks on the subject is given on page 53 of this issue.

If signalling, or disobedience to signals, is often responsible for railway accidents, the design of carriages as often mitigates or aggravates the effect. No firm conclusions on coach design in relation to the Harrow accident are given in the report. Colonel Wilson believes it is possible that the wreckage might have been less compact, and the killed and injured fewer, if a greater proportion of the rolling stock had been of the latest all-steel type and rigidly coupled. In this design the underframe is nearly twice as strong as that of any of the former Regional designs. The corridor coaches have central Buckeye couplings, which were standardised by the former London and North Eastern and the Southern Railway companies for their main-line stock and have proved their value on past occasions in reducing the risks of telescoping. The weight of the new corridor coaches, in spite of their increased strength, is no more than 34 tons, which is regarded as about the maximum that can be accepted in this country, where a definite limit is set to locomotive haulage power by the restricted loading gauge. Colonel Wilson visualises, for the future, carriages in which the body and underframe are developed as a more or less homogeneous structure, each reinforcing the other so as to enable the best use to be made of all the material to resist shock loads. The new British Railways coaches, he says, go a long way in this direction, though no practicable form of carriage construction can ever prevent casualties when, as at Harrow, the enormous momentum of several trains is dissipated in a few seconds. Three passenger coaches of the local train, three of the Perth train and seven of the Liverpool train, as well as two bogie vans and a kitchen car, were demolished or very heavily damaged; 13 of these 16 vehicles were compressed into a compact heap of wreckage about 45 yards long, 18 yards wide and 30 ft. high, completely burying the engine of the Perth train.

The fireman of the leading engine of the Liverpool train, which was "double-headed," had a remarkable escape. He was thrown clear of the engine and found himself on the upturned wheel splasher of the train engine. Apart from train crews, however, no less than 36 of the passengers who were killed, and many of the injured, were members of the railway staff travelling to work in London, most of them in the London Midland Region offices at Euston. There were three railway officers in the fourth coach from the rear of the local train who escaped—Mr. S. Williams, the signal and telecommunications engineer, Mr. F. W. Abraham, the motive-power superintendent, and Mr. L. Rowlands, of the operating superintendent's department at Euston.

Only once before has there been a greater death roll in a British railway accident—at Quintinshill, Gretna, on May 22, 1915, when a double collision resulted in the deaths of 227 persons. Such disasters shock the nation into a sudden realisation that the day-in day-out service of the familiar trains can be interrupted by the chance in a million, and the familiarity turn to horror and anguish. The cry goes up for technical improvement; no expense must be spared. But there is no limit to possible improvement—except money and time, and a sense of proportion. Which plan for the extension of automatic train control is to be adopted, and on what basis is the decision to be reached?

# NOTES.

## SUMMER MEETING OF THE INSTITUTION OF MECHANICAL ENGINEERS.

THE excellence of Sheffield as a centre for the summer meeting of the Institution of Mechanical Engineers is well brought out in the address Mr. M. A. Fiennes, M.I.Mech.E., gave during the opening meeting last week. This address is reprinted, in abridged form, on page 57 of this issue (we regret, however, that the numbers of the Plates in the text of the address are given as XXVII to XXX, whereas they should be I to IV; the pages concerned were passed for press before the error was noted). The diversity of Sheffield engineering and its foundation of metallurgy were also reflected in the wide range of works and other establishments visited; there was a choice of 42 for visits on the three days of the meeting. The Lord Mayor of Sheffield, Councillor Oliver S. Holmes, welcomed the President of the Institution, Mr. Alfred Roebuck, the Council and members, with their ladies, in the City Hall on Wednesday, July 1. Sir Harold West, Master Cutler, welcomed the guests on behalf of the concerns whose premises were to be visited. In replying, the President said it was 63 years since the Institution had held a Summer Meeting at Sheffield, and that it was interesting to recall, in view of the pride of place held by Sheffield in the production of high-grade steels, that at that meeting, in 1890, three papers were presented by certain members who bore the names of Brown, Bessemer and Vickers, to whom Sheffield owed so much. Mr. Fiennes's address was followed by one on "The Metallurgical Industries of Sheffield," by Dr. Charles Sykes, M.I.Mech.E., F.R.S. This address will be reprinted in next week's issue of ENGINEERING. At the Institution Dinner, held in the Cutler's Hall on Thursday, the toast of "The City and Trade of Sheffield" was proposed by Sir George Nelson, vice-President. He paid a tribute to the President, Mr. Roebuck, who was born and bred and had worked all his life in Sheffield. In responding to the toast, the Lord Mayor said, in regard to the growth of industry in Sheffield, that whereas a hundred years ago there were but 20,000 dwellings in the town, to-day there were 145,000. The Master Cutler, Sir Harold West, who also responded, said that relations in industry in Sheffield were such that there had been no serious strike for 26 years. Speaking of special steels and the virtual monopoly held by Sheffield in the production of jet-engine steels, he stressed the need for continual research. The President, proposing the toast of "The Guests," said that Sheffield, on this occasion, was truly serving the Institution well, and in regard to Institution matters he said there were now 39,600 members. It was gratifying to know that 18 per cent. of the members present at the dinner were graduates or students of the Institution. In responding, Mr. Gerard Young, Pro-Chancellor of the University of Sheffield, thanked the President and members on behalf of the guests and said that new buildings in the University would cost over 500,000*l.* by the time they were completed in 1955. Their completion would enable the number of trained engineers graduating annually from the University to be trebled.

## THE FRENCH AIRCRAFT INDUSTRY.

The French aircraft industry, which has recently concluded its 20th biennial exhibition in Paris, includes both nationally-owned and private manufacturing companies. A description of some of the most interesting developments on view is given on page 42. The national companies comprise the Société Nationale de Constructions Aéronautiques du Nord (S.N.C.A.N.), Société Nationale de Constructions Aéronautiques du Sud-Est (S.N.C.A.S.E.), Société Nationale de Constructions Aéronautiques du Sud-Ouest (S.N.C.A.S.O.), the Société Nationale d'Etude et de Construction de Moteurs d'Aviation (S.N.C.E.M.A.), and the Société Francaise d'Etude et de Construction de Matériels Aéronautiques (S.F.E.C.M.A.S.). With the exception of the latter company, which is concerned primarily with guided-missile research, both national companies and privately-owned firms take part in series production and in the design and development of prototypes, many of which are of great interest and originality. Among the private companies currently engaged in military production may be mentioned Avions Marcel Dassault, producing a proportion of the Dassault Ouragan and Mystère fighter aircraft for the French air force; Société Morane Saulnier, who are constructing M.S. 475 and M.S. 733 military training aircraft and propellers, and the Société d'Exploitation des Matériels Aéronautiques Hispano Suiza, who are producing under licence from Rolls-Royce Limited the Nene and Tay jet engines installed in many French aircraft now under construction. Current production in the government companies is as follows: SNCAN, the Nord 2501 twin-engine military transport aircraft, and the NC 856 artillery-spotter aircraft; SNCASE, under licence, the Vampire Mark V, and the Mistral, their own development of the Vampire, with a Hispano Suiza Nene engine, larger air intakes, and a re-designed wing structure and fuel system; the Sea Venom and, shortly, the Sikorsky S.51 helicopter; and, on the civil side, they have recently completed the construction of four SE 2010 Armagnac 50-ton four-engine air liners in service with Transport Aériens Intercontinentaux. SNCASO are at present producing components for the Dassault Ouragan and Mystère aircraft, and will shortly be producing their SO 4050 Vautour ground-support aircraft; and SNECMA, who are producing their ATAR 101 jet engine (described in ENGINEERING on page 173 of our 172nd volume, 1951), in addition to some small reciprocating engines and, under licence, Bristol Hercules engines. Production by private companies includes the Breguet Deux-Ponts transport aircraft (one of these machines has been delivered recently to the British charter company, Silver City Airways, and is to be evaluated as a freighter by them on the Berlin-Hamburg route); and, in contrast to the United Kingdom, France has an active section of the industry engaged in the design and construction of light aeroplanes for private flying.

## APPOINTED DAY FOR IRON AND STEEL ACT.

Monday next, July 13, has been fixed by the Government as the "appointed day" for the denationalisation of the iron and steel industry, in accordance with the provisions of the Iron and Steel Act, 1953. As from that day, the measures for the State ownership of the industry, passed by the Labour Government in 1949, will be repealed. The new Iron and Steel Board for the supervision of the industry will commence its duties then, and the securities of the various iron and steel undertakings, at present held by the Iron and Steel Corporation, will pass simultaneously to the Holding and Realisation Agency, which will arrange, eventually, for their return to private ownership. The Agency, however, is not committed to any particular marketing schedule simply by the fixing of the appointed day, because, under the provisions of the Act, it possesses complete discretion, subject only to the consent and general supervision of the Treasury, to choose what securities shall be sold, and when. The duties of the Agency will be to act as both a holding company and a selling company for the securities concerned, which have an estimated market value of around 300 million pounds. The general expectation at present appears to be that sales will not be begun until the autumn and that they will then be confined to equity shares. When reporting the fixing of the appointed day to the House of Commons on June 29, Mr. Duncan Sandys, the Minister of Supply, stated that the chairman of the Iron and Steel Board and the Agency had been consulted, and had recommended the choice of either July 6 or July 13 as the date for the change-over to take place, and that the latter date had been selected, out of consideration for the views of the Opposition. The Minister rejected a suggestion that the date should be postponed until after the next general election. He also declined proposals for the publication of an abridged and illustrated edition of the recent report of the Iron and Steel Corporation, on the ground that

there was unlikely to be any large public demand for such an edition.

### SUMMER MEETING OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

For the first time since 1927 the Summer Meeting of the Institution of Electrical Engineers took place on Tyne and Tees-side, from Monday, June 29, to Friday, July 3. About 300 members and ladies attended, including the President (Colonel B. H. Leeson) and Mrs. Leeson, and the excellent arrangements made both by the Institution's staff and that of a special sub-committee of the North Eastern Centre enabled a good idea to be gained of the way the electrical industry in the area has developed during the interval. More detailed information regarding the various visits will be given in a subsequent issue of ENGINEERING, but it may be mentioned that these included inspections of the works of Messrs. C. A. Parsons and Company, Limited, at Heaton, of Messrs. A. Reyrolle and Company, Limited, at Hebburn, of Messrs. W. T. Henley's Telegraph Works Company, Limited, at Birtley, and of the Lemington Glass Works, Limited. The factories of Imperial Chemical Industries, Limited, at Wilton and Billingham were also visited, as were the Cleveland Iron and Steel Works of Messrs. Dorman, Long and Company, Limited, and the works of Messrs. Richardsons, Westgarth and Company, Limited, at Hartlepool, and of Messrs. Siemens Brothers and Company, Limited, at West Hartlepool. Those interested in electricity supply were given an opportunity of seeing the North Tees C and Dunston B power stations of the North Eastern Division of the British Electricity Authority in operation and the new Stella A and Stella B stations in course of construction. The Hetherington Burn sub-station of the North Eastern Electricity Board was also inspected and visits paid to the works of Messrs. Clarke, Chapman and Company, Limited, Gateshead Pyrotenax, Limited, Hebburn, and the Bushing Company, Limited, Hebburn. The shipyards of Swan, Hunter, and Wigham Richardson, Limited, and Vickers-Armstrongs Limited, were also inspected and a number of non-technical excursions made.

### CORONATION RECEPTION BY THE LONDON COUNTY COUNCIL.

Her Majesty the Queen conferred the honour of knighthood upon the Rt. Hon. Mr. Arthur E. Middleton, chairman of the London County Council, at the Coronation Reception held at the County Hall, London, on Monday evening, July 6. Her Majesty, who was accompanied by H.R.H. the Duke of Edinburgh, was received by Viscount Alanbrooke, Lord Lieutenant of the County of London, the Chairman of the Council, and Sir Howard Roberts, clerk to the Council. The Royal party included the Duke and Duchess of Gloucester, the Duchess of Kent, Princess Alice, Countess of Athlone, and the Earl of Athlone and Princess Marie Louise. The guests, who numbered about 1,500, were received by the chairman and Mrs. Middleton, the vice-chairman (Mrs. I. M. Bolton) and Mr. Bolton and the deputy chairman (Mr. Frederick Lawrence) and Mrs. Lawrence. A display of the Council's silver plate was arranged in the Members' library, and other special exhibitions included records of the Council's Royal guests from 1897 to 1953, a comparison of "London Pleasures" in the reign of Elizabeth I with those of the present reign, and others illustrating the activities of the Council in architecture, the promotion of road safety, etc.

### NEW ROLLING STOCK FOR BRITISH RAILWAYS.

British Railways are to build 288 locomotives, 1,448 carriages and 42,641 wagons during 1953, providing the full allocation of materials is received. The programme includes locomotives and rolling-stock authorised during previous years but not built owing to shortage of materials, together with part of the normal 1953 programme of construction. The 288 locomotives will include 209 steam and one Diesel-electric main-line locomotive, 51 Diesel-electric shunters of the new standard type, 14 Diesel-mechanical shunters, and 13 electric locomotives for the Manchester-Sheffield-Wath services. Of the steam locomotives, 150 will be of the standard designs and 59 of existing regional types; the first ten of a new 2-10-0 Class 9—the most powerful locomotive yet designed by British Railways and the first standard type to be designed exclusively for heavy freight traffic—will be included in the 150 standard locomotives. Most of the carriages will be of the new standard all-steel designs, but 292 will be of regional non-corridor types, for which much of the material is already on hand. A feature of the wagon-building programme is the provision of 1,200 wagons, of capacities ranging from 12 tons to 42 tons, for carrying the record quantities of steel now being produced; other features are 113 wagons ranging from 12 to 135 tons capacities for special types of traffic, and 2,324 wagons with shock-absorbing gear. Twenty-five per cent. of all the wagons, including most of the general merchandise wagons, will be fitted with vacuum brakes to enable them to run in express freight services.

### BRITISH NON-FERROUS METALS FEDERATION.

In the course of his presidential address, delivered during the annual general meeting of the British Non-Ferrous Metals Federation, held in Birmingham on July 2, the newly re-elected President, for the year 1953-54, Mr. H. E. Jackson, stated that the Federation had been able, thanks to its excellent relations with Government departments, to express its views on many of the measures of de-control that had occurred. The Federation had been heard on matters arising from the de-control of lead, tin, zinc, and copper, on the problem of international allocations, on "end-use" control (which had disappeared for all metals except nickel), on the progressive measures for the de-controlling of prices (including scrap prices), and on licensing. In consequence, these various developments had come in a way which had been less irksome to the industry than would otherwise have been the case. The Federation should continue to work at all times to secure the lowest possible price for its main material, copper, but a stable price was no less important than a low price. Considerable fluctuations in price made it impossible to secure a steady demand and, therefore, to have planned production. The Bureau of Statistics, in which the Federation had the collaboration of the mining interests and the smelters, was an instrument which could make a great contribution. The Bureau had planned to extend its services to cover the world and, with the resumption of copper dealings, this should enable the Bureau to make a more positive contribution to essential knowledge concerning the movement of metals and thereby to stability in price, to the advantage of producers and consumers alike. The way was now clear for a full-blooded export drive in which all who could should participate. Exports from this country, however, were still subject to Government licence. Competition in export markets had been intensified in the past year and it was more than an irritant, when fighting this competition, to be subjected to delays in the granting of export licences which could result in the loss of business. Great industries had become the plaything of politics, and this "bedevilled" an industrial community which should have its whole energy concentrated on the task of running itself competitively in a fiercely competitive world.

### THE INSTITUTION OF LOCOMOTIVE ENGINEERS.

The outstanding services of Mr. R. A. Riddles, C.B.E.—and of his staff on British Railways—have been recognised by the Council of the Institution of Locomotive Engineers. He has been awarded the Institution's highest award—the Gold Medal. The presentation will be made at the Institution's opening general meeting of the 1953-54 session in September. The Gold Medal was first awarded in 1946, posthumously to the late Mr. C. E. Fairburn, and later to Mr. E. S. Cox, who is a member of Mr. Riddles's staff. It is awarded, at the discretion of the Council, for special or meritorious service in connection with the profession of locomotive engineering. Mr. Riddles has been the member of the Railway Executive responsible for mechanical and electrical engineering since the British Railways organisation was set up on January 1, 1948. In that capacity he has directed the design and construction of the standard steam locomotives, which embody the best features of locomotive design inherited from the former railway companies. In less spectacular matters, but of perhaps greater significance economically, he has been responsible for new policies in carriage and wagon construction and in many other facets of mechanical and electrical engineering on British Railways.

## OBITUARY.

### MR. S. G. RATTEE.

WE regret to record the death of Mr. S. G. Rattee, which occurred on Saturday, June 27, at the age of 59. He was well known in electrical circles as an able journalist and recorder of current events.

Stanley George Rattee was born in London on September 9, 1893, and was educated privately and at Clapham High School. He subsequently attended the British School of Telegraphy and the school of Marconi's Wireless Telegraph Company at Seaforth, and then served as wireless telegraphist on ships of the Canadian Pacific and Cunard Lines. During the 1914-18 war he was engaged on similar duties in the Royal Navy and became assistant editor of the *Wireless World* in 1920. Subsequently he established a name for himself as a free-lance journalist on subjects relating to radio communication, and in 1923 was appointed staff editor of Radio Press, Limited. In 1927, he joined the staff of our contemporary *The Electrician* (now the *Electrical Journal*) as assistant editor and was promoted to be editor in 1940. Although he had suffered ill health for some time he had been actively engaged on his duties to within a short time of his death. He was also chief editor of the well-known *Electrical Trades Directory* and *The Electrician Red Book*. Mr. Rattee was elected an associate member of the Institution of Electrical Engineers in 1943.

## LETTER TO THE EDITOR.

### TEMPERATURE CONTROL OF MOLTEN GLASS FEEDER.

TO THE EDITOR OF ENGINEERING.

SIR,—An article on page 671 of your issue of May 22, 1953, describes a temperature control system in which a recording potentiometer controller varies the heat input to a gas-fired glass feeder by positioning a diaphragm-operated valve in the combustion-air line, thus maintaining constant temperature.

I would like to draw attention to the fact that a control system of this description, known as the Brown temperature control system, has been in use for many years in the United States. Utilising the "Electronik" instrument manufactured by Honeywell-Brown, Limited, Perivale, Middlesex, this system has also been available to glass manufacturers in Britain since 1948, when it was first installed in a glassworks in England by British Hartford-Fairmont, Limited. Platinum-sheathed thermocouples, manual control panels and limit signals have been standard features of the many subsequent installations.

The most recent progress in this field has been the development by British Hartford-Fairmont, Limited, of a new system of control for oil-fired forehearths, which gives results comparable with those previously obtainable only with gas-fired forehearths. It is intended to publish a description of this new application in the near future.

Yours faithfully,
F. W. J. HOWARD,
Electrical Engineer,
British Hartford-Fairmont, Limited.
Rockware-avenue,
Greenford,
Middlesex.
June 29, 1953.

# AIRCRAFT CARRIER WITH ANGLED FLIGHT-DECK.

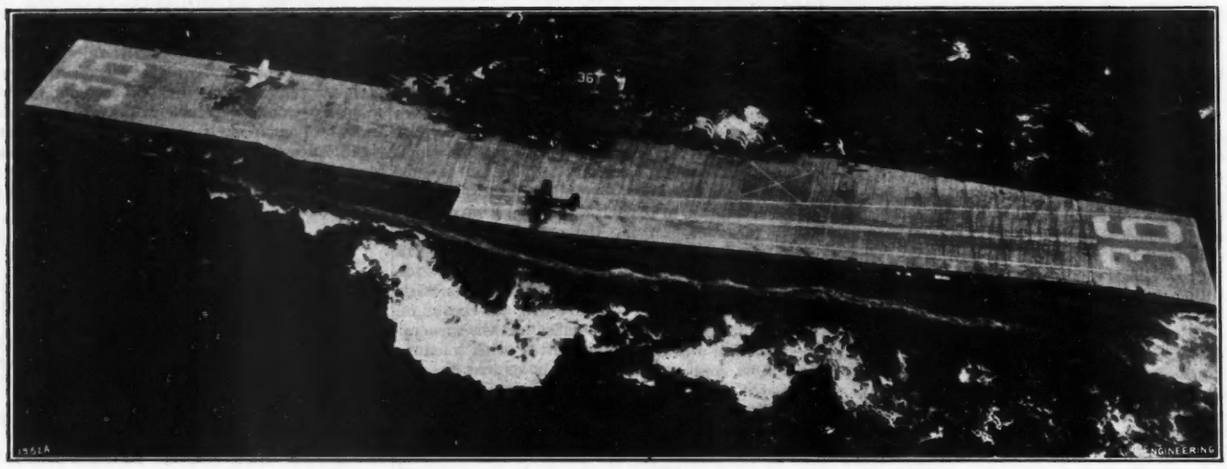

FIG. 1. U.S.S. "ANTIETAM" AT SEA.

## AIRCRAFT CARRIER WITH ANGLED DECK.

FROM their inception, aircraft-carriers have been constructed with a single long flight-deck, co-axial with the hull of the ship, from which aircraft could take off at the forward end, and on which they "landed on" at the after end; the carrier steamed into the wind during both operations to provide, in the first instance, the maximum wind speed, relative to the aircraft, for taking off, and, in the second, the most favourable condition for "landing on." There was always the possibility, however, that an aircraft which failed to pick up the arrester wires on landing might charge into the aircraft parked on the forward end of the flight deck in readiness for taking off. To avoid this risk, it was suggested by Captain D. R. F. Cambell, D.S.C., R.N., then Deputy Chief Naval Representative at the Ministry of Supply, and Mr. L. Boddington, of the Royal Aircraft Establishment, that the after end of the flight deck might be constructed at an angle to the axis of the ship, so that aircraft which might overshoot the arrester wires could fly off again without endangering the parked aircraft at the forward end of the flight deck.

Preliminary trials of this device were carried out in H.M. Aircraft Carriers Triumph and Illustrious without actually reconstructing their flight decks; the modified landing-on paths were marked out on the existing decks and were found to be feasible. It was decided, therefore, to alter the flight deck of the carrier Hermes, now nearing completion at Barrow-in-Furness; but, meanwhile, the particulars of the new technique had been communicated to the United States Navy, which undertook the complete conversion of the carrier Antietam, with angled flight deck, angled arrester wires and an extension of the flight deck on the port side, as can be seen in the illustration, Fig. 1, herewith. The Antietam, a vessel of 37,500 tons displacement, was laid down at the Philadelphia Navy Yard on March 15, 1943, and was commissioned on January 28, 1945. The Japanese had surrendered before she went into service, but she operated in support of the occupation of Japan until 1949, when she was placed in reserve. In January, 1951, she was recommissioned for service in the Korean conflict and in September, 1952, was withdrawn to be fitted with the new angled deck—known in the United States Navy as a "canted" deck—the axis of which is at an angle to port of rather more than 8 deg. from the centre line of the ship. Her present commanding officer, Captain S. G. Mitchell, U.S.N., made the first landing on it on January 12, 1953, since when many thousands have been made without mishap, at least 3,000 by pilots who were relatively inexperienced.

The Antietam (pronounced An-teet'-am, the Indian name of a creek in Maryland, over which was fought one of the most important battles of the American Civil War, in September, 1862), has been on a visit recently to British home waters, and on July 1, by invitation of the British Admiralty, we were enabled to witness on board of her a demonstration of the use of the new angled deck. Originally, the vessel had three aircraft lifts, two on the centre line and the third, of the "deck-edge" type, on the port side. The construction of the angled deck, as an extension to port of the existing deck, involved the abandonment of the deck-edge lift, as the angled deck was constructed over and beyond it; its position is approximately beneath the aircraft abreast of the "island," in Fig. 1. The overall length of the flight deck is 876 ft., and its average width is 100 ft., not including the projection of the angled deck, of about 25 ft. on the port side. The centre line of the angled deck is at an angle of 8 deg. 9 min. to that of the ship, but it is proposed to increase this angle to 10½ deg. in future vessels and the inner white line, marking out the angled deck, lies at this angle, for experimental purposes; this also can be seen in Fig. 1. Originally, the

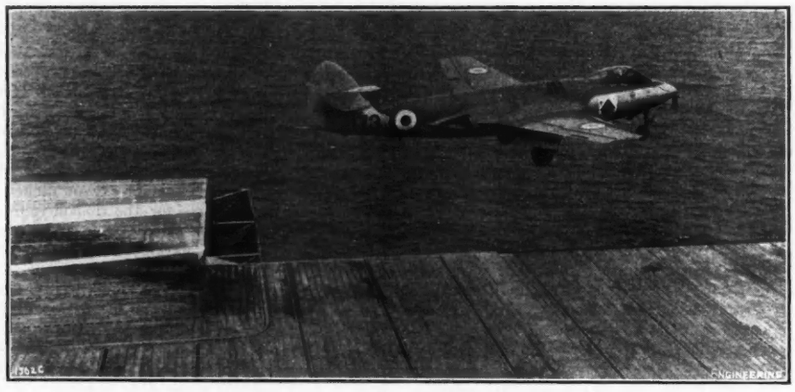

FIG. 2. "SEAHAWK" TAKING-OFF FROM ANGLED DECK.

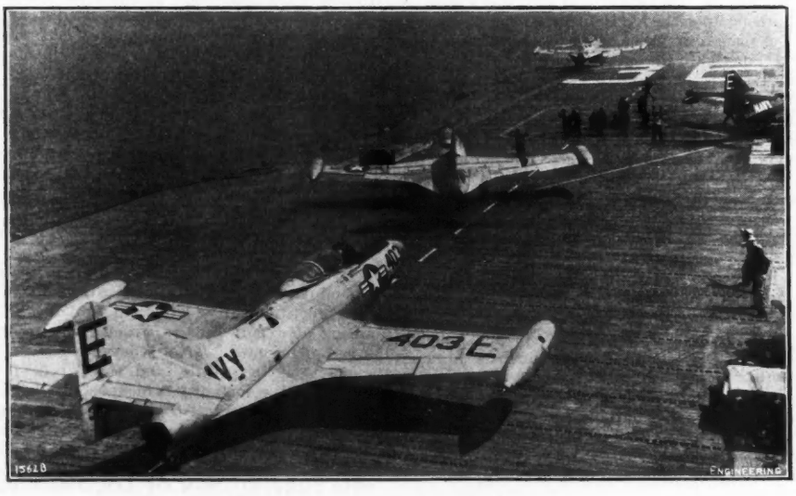


FIG. 3. "PANTHER" LEAVING CATAPULT.

vessel was fitted with 12 arrester wires, but this number has now been reduced to six, which is found to be ample in practice. There are no permanent crash barriers to stop aircraft which may fail to pick up the wires; but a barrier can be rigged if necessary, to stop an aircraft which has had its arrester hook damaged or shot away. This evolution was demonstrated on the occasion of our visit, when the barrier was erected in 1 min. 15 sec.

The aircraft employed in the demonstration included the Panther, Skyknight and Guardian machines of the United States Navy, and Attacker, Seahawk, Meteor, Wyvern, Sea Venom and Sea Vampire machines belonging to the Royal Navy. They included both jet-propelled and piston-engined types, and each was to make five "touch and go" landings before coming in to pick up the wires. Fig. 2 opposite, shows a Seahawk taking off from the angled deck. The demonstration was most effective in showing the advantages of the angled deck, as the aircraft in flight were able to make their landings while others were in process of being catapulted from the forward end of the flight deck. The catapults used were of the steam-operated type invented by Commander (E) C. C. Mitchell, O.B.E., R.N.V.R., of Brown Brothers and Company, Limited, Rosebank Ironworks, Edinburgh, and first fitted in 1949 in H.M. Aircraft Carrier Perseus. In this type, the hook to which the aircraft is connected is directly attached to a piston which is driven along a cylinder by high-pressure steam from the ship's main boilers. With the use of two catapults, one on each side at the forward end of the flight deck, aircraft can be put into the air at the rate of about one in every 15 seconds. Fig. 3, opposite, shows a Panther jet-engined fighter being catapulted while other machines are being brought into position.

The weather conditions were not favourable when the Antietam put to sea on the morning of July 1, with the destroyer Charles J. Badger in attendance, as there was a heavy mist which caused a postponement of the morning programme. By midday, however, the mist had lifted to some extent, and eventually the full programme was completed. It was noticeable that, although the number of arrester wires had been halved, six wires proved to be more than ample for most of the landings; No. 6 wire came into use on comparatively few occasions. No. 1 wire was situated 80 ft. forward of the ramp at the after end of the deck, and the subsequent wires were spaced at intervals of 20 ft. from it. Most of the aircraft were hooked on Nos. 2 and 3 wires, so far as we were able to judge. An unintentional demonstration of the advantage of the angled deck was provided when one of the British naval aircraft, coming in to land, failed to get its hook down far enough to engage with the wires. It could not have run along the axial deck, as several other aircraft were being brought up to the catapults for launching; but on the angled deck it was able to fly straight off again, the pilot being subsequently instructed by radio-telephone to return to the Royal Naval Air Station at Ford.

We may add that the large party of observers of the tests on July 1 were most favourably impressed by the teamwork of the handling parties on the flight deck and the hangar deck, who carried out their several functions with an absolute minimum of spoken orders. This, in fact, is essential, as a man's voice has little chance of being heard in competition with the noise of aircraft engines, jet or otherwise, being run up to flying speed. The various parties wear jerseys of different colours, the leading petty officers having their respective titles stencilled on the backs. The effect may be to suggest a number of baseball teams rather than the combatant crew of a warship, but there can be no question of the efficacy of the system in practice.

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INTERNATIONAL COUNCIL FOR BUILDING RESEARCH.—On June 25 at the European Office of the United Nations an International Council for Building Research was established. The "founder members" included the Building Research Station of the Department of Scientific and Industrial Research, the director of which, Dr. F. M. Lea, was appointed director of the Experimental Research Section of the Council.

# AUTOMATIC TRAIN CONTROL ON BRITISH RAILWAYS.

LIEUT.-COLONEL G. R. S. WILSON (chief inspecting officer of railways), in his report* of the inquiry he conducted into the railway accident which occurred at Harrow and Wealdstone station on October 8, 1952, reviews the development of automatic train control in the past half century. Referring to tests carried out in March this year with equipment of the "final prototype design" for British Railways, he says that it stopped a train within a safe distance with no action by the driver when an outer distant signal at caution was passed at 93 miles an hour, though the regulator was left open during the stop, with the reversing gear at 35 per cent. cut-off. That part of Colonel Wilson's report dealing with automatic train control is given below, abridged, and a leading article on page 49 discusses the report as a whole.

### THE CASE FOR WARNING CONTROL.

In the 41 years 1912 to 1952, formal inquiries were held into 640 train accidents, in which 1,416 persons were killed. Of these accidents, 66, or rather more than 10 per cent., might have been prevented or mitigated by automatic train control of warning type, but the fatalities which might have been saved were 28 per cent. of the 41-year total, or 399 lives in all, including 112 at Harrow. The much greater proportion of the fatalities is not fortuitous, as warning control affords valuable protection against failure to act on the distant signal at caution, which may well lead to a collision or turn-out derailment at high speed with very serious consequences, experience having shown that if speed is not reduced when the distant is passed at caution there is a grave risk that subsequent stop signals may also be disregarded. The high value of warning control under main-line conditions is also emphasised by the fact that if more elaborate and much more costly forms of apparatus, such as continuous cab signals, speed control or train stops had been in use as well as warning control, the proportion of fatalities which might have been saved would only have risen from 28 per cent. to 36 per cent. That, in short, is the case for warning control.

For many years the Government, acting on recommendations of the inspecting officers of railways, had urged that the fullest consideration should be given by the railways to the extension of automatic train control, and special committees were appointed in 1922 and 1927 to review the question, the latter under the chairmanship of Colonel Sir John Pringle, who was then chief inspecting officer. The "Pringle Committee" reported in 1930 and recommended increasing safety by direct (automatic) and indirect methods, with a general preference for the former and emphasis on the contact system which the Great Western Railway had begun to develop in 1905, and which was already in fairly extensive use. The committee took note, however, of the non-contact magnetic Hudd system and suggested that it should be tried under working conditions. With regard to indirect methods, the committee included recommendations for increasing the illuminative and penetrative power of signal lights and the extension of certain types of block control to prevent errors by signalmen. The report was referred to the railway companies, but, except for the Great Western, they did not consider that automatic train control, which would require apparatus on the train, was justified, on account of the great expense and the small number of accidents which it would prevent, and they proposed that indirect methods should be fully developed. They agreed, however, that further exploration of automatic train control generally was desirable.

In 1931 and 1932, trials were carried out with the Hudd system by the Southern and London Midland and Scottish Railways, and in 1937 the latter company proceeded to install it on their London, Tilbury and Southend section and equipped 150 locomotives for the purpose. This installation was finally approved by the Minister in 1947, on the recommendation of the chief inspecting officer. The system has since worked satisfactorily in all weathers. In the meantime, the Great Western Railway had been steadily extending their contact system, and on the outbreak of war in 1939 the great majority of their main-line mileage and practically all their locomotives had been equipped. The London and North Eastern Railway had kept in touch with the London Midland and Scottish trials, and in 1938, after the serious collision at Castlecary, were beginning to install the Hudd system between Edinburgh and Glasgow, but the work was stoppped by the war.

The Southern Railway, on the other hand, while satisfied with the results which had been gained, decided not to proceed further with the matter at that time, preferring to spend their money on colour-light signalling with continuous track-circuiting, the heavy cost of which was justified by their intense electric passenger services; they maintained, with some justification, that the arresting effect of a succession of colour-light signals made automatic train control less necessary, and that track-circuiting was a strong safeguard against signalmen's mistakes, which could not be prevented by automatic train control.

### COST OF AUTOMATIC TRAIN CONTROL.

The subject was again brought into prominence by the serious accident at Bourne End in 1945, where a colour-light distant signal was disregarded or misinterpreted in daylight and clear weather. The report of Lieutenant-Colonel Sir Alan Mount, then chief inspecting officer, included a strong recommendation for the application of warning control to main lines, and the railway companies were asked to deal specially with this and other items in submitting to the Minister their proposals on the recommendations of the report. They replied in December, 1947, and the letter contained the following paragraph: "It should be pointed out that, apart from the question of finance, the general installation of automatic train control, even of the warning type, on main lines where this does not already exist, would occupy a considerable time and employ a large number of skilled men. The supply of such staff is strictly limited, and its employment on this installation would therefore necessarily delay the execution of other work, such as the modernisation of signalling, the extension of track-circuiting and other similar works."

That was the general position when the British Transport Commission and the Railway Executive assumed control on January 1, 1948. In the meantime another serious accident had occurred at Goswick, where a semaphore distant was ignored at caution, and Sir Alan Mount concluded his annual report for 1947 with a reference to automatic train control in the following terms: "There are substantial grounds for the extension of such equipment, and it deserves high priority in relation to other operating and signalling improvements, particularly as the majority of railway mileage is likely to remain signalled under the semaphore system for a long time."

Thus there were two systems of warning control in established day-to-day service on the vesting date. By far the most extensive was the Great Western contact system, which was in use on 1,356 miles of route. It works by means of a fixed insulated ramp at the distant signal, by which a plunger on the locomotive is raised. When the distant is at caution the ramp is "dead" and the raising of the plunger sounds a siren in the cab and gives an application of the brake which can be cancelled by the driver. With the distant at clear, a small electric current is applied to the ramp, which prevents the siren and brake from acting, and causes a bell to sound in the cab; the current is returned through the running rails.

The Hudd system, as modified by the London Midland and Scottish Railway, was in use on 37 route miles between Fenchurch Street, Tilbury and Southend. It is a magnetic system which does not depend on physical contact. A permanent magnet, followed at a short distance by an electromagnet,

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* *Report on the Double Collision which occurred on 8th October, 1952, at Harrow and Wealdstone Station in the London Midland Region, British Railways.* H.M. Stationery Office. [Price 5s. net.]

is located between the rails at the distant signal. With the distant at caution, the electromagnet is not energised, and the permanent magnet reverses inductively the armature of a receiver under the locomotive; reversal of the armature opens a small valve to reduce the vacuum in a pilot reservoir, which, in turn, sounds a siren and gives a cancellable brake application, as in the Great Western system. With the distant at clear the electromagnet is energised to an opposite polarity. The siren begins to sound at the permanent magnet, but it is quickly suppressed as the receiver armature is restored to normal by the electromagnet before the brake can take effect. The equipment operates pneumatically, and there are no electric circuits on the engine. The audible signals on the footplate, namely, a long sound of the siren for caution and a short sound of the same note for clear are not nearly so distinctive as the siren and bell of the Great Western system. The position in the Western Region and on the Tilbury and Southend line remains unchanged today, with a total of 1,393 route miles equipped with warning control.

### RAILWAY EXECUTIVE'S PROPOSALS.

After some small-scale comparative trials early in 1948, and discussions with the inspecting officers, the Railway Executive put forward tentative proposals for a programme to extend warning control on main-line routes based on one or another of the two systems. They considered that it should be initiated as soon as circumstances would allow, and envisaged an expenditure of some 6*l*. millions staged over six years, but they indicated that the technical problem was not fully solved and that further research was necessary. They also recommended a programme of the same order for the extension of track-circuiting and block controls to prevent errors by signalmen.

The Railway Executive then gave their consideration to the merits of the two systems. At first they were inclined to favour the Great Western contact system, which had operated successfully for many years under steam traction, but subsequent tests with it showed that there was a serious risk of false indications by stray earth currents on lines electrified either with conductor rails or overhead collection; it was also found that there was insufficient clearance between the ramps and the motor cases of multiple-unit electric trains. These alone were felt to be important objections to the adoption of the system as a long-term future standard for all forms of traction, and after reviewing the question further the Executive also considered that it would be unwise to standardise a system in which heavy mechanical parts were brought into contact with each other at a time when more modern methods of "pick-up" were available. Other objections of less moment were also mentioned, including the interference of the ramps with snow ploughs under severe conditions in the North and difficulties of adapting the equipment to fit the variety of cab layouts in other Regions. Although the Hudd system embodied the non-contact principle which was desired, it was not considered wholly satisfactory mainly because there was not sufficient differentiation between the caution and clear indications.

After a series of meetings with the inspecting officers, the Railway Executive proposed in August, 1948, that apparatus combining the best features of the two systems should be developed. After examining a sketch design, the inspecting officers informed the Executive that they saw no inherent objection to it, subject to unquestioned proof of its reliability and efficiency in large-scale trials, for which they suggested at least 12 months would be required. The inspecting officers, however, expressed the strong opinion that the Great Western contact system, which was already well proven, should not be discarded without thorough investigation of means to protect the ramp against false energisation in electrified areas.

The Railway Executive, after further consideration, decided to develop the "compromise" apparatus, the first tests of which were carried out in the spring of 1949, and the results were sufficiently encouraging to justify a large-scale trial under fast-running main-line conditions. The down main line between Barnet and Huntingdon on the East Coast route to Scotland was selected for the purpose and it was decided to equip 65 locomotives. Track magnets and engine receiver units supplied before the war for use in Scotland were modified for these trials, and Western Region cab units were sent to signalling contractors for modification and fitting of relays.

Good progress was made with installing the track equipment, but there was considerable delay in the supply of modified cab equipment and, as the first few fitted engines came into service, it was found that the modified Great Western cab equipment could not give sufficient braking force with the different type of brake system in use in the Eastern Region; this trouble was eventually overcome by further modification of the cab equipment on the "vacuum" side. Difficulty was also experienced in locating the various components in the Eastern Region cabs where they could be best protected from vibration and the ingress of dirt and dust. As a result, the trials did not get into full swing until December, 1950, when 54 engines had been fitted with a modified apparatus. The trials continued during 1951, but the alteration of the original Hudd-type receiver unit to work electrically introduced many technical problems, although it had already proved its reliability on the Tilbury line under pneumatic operation. There was no great difficulty with the track equipment, but the electrical equipment in the cab was necessarily more complex than the standard Great Western type, and a succession of safety-side failures proved very difficult to trace to their source and eliminate.

The Executive therefore decided in April, 1951, to appoint a small committee of technical officers to carry out a thorough investigation on more systematic lines. Special testing apparatus was devised by the committee, which proved very valuable in tracing the source of each failure and they were eliminated one by one by minor changes of design and by improving the workmanship of wiring and other details. Further failures which occurred in the first few months of 1952 were more easily dealt with, and by August, 1952, drawings for what was hoped would be the final prototype design were completed and the first set was fitted to a locomotive and put into service on October 17, 1952. In the meantime the accident at Harrow had occurred.

By the end of March, 1953, 54 locomotives had been fitted with the final prototype design. The details of its working were thoroughly examined by the inspecting officers of railways, who witnessed its working on two occasions in March and April from the footplate of an engine hauling a 12-coach train between King's Cross and Huntingdon. On both these trips the equipment operated satisfactorily at all of the semaphore distants and the multi-aspect colour-light signal locations which were passed at caution and clear; it stopped the train within a safe distance with no action by the driver when an outer distant at caution was passed at 93 m.p.h., although the regulator was left open during the stop with the reversing gear at 35 per cent. cut off.

### FINAL PROTOTYPE DESIGN.

This report is not the place for a detailed technical description of the apparatus as finally designed, but the following is a brief summary of its layout and functioning from the point of view of train operation. The track equipment, consisting of a permanent magnet followed closely by an electromagnet, is situated approximately 200 yards on the approach side of each semaphore distant and multi-aspect colour-light signal. Semaphore stop signals are not equipped. A bell is sounded in the cab for 2 to 4 seconds when a semaphore distant is clear or a multi-aspect signal is showing green When a semaphore distant is at caution or a multi-aspect colour lght is at double yellow, yellow or red, the siren sounds and a brake application commences. The siren and brake can be cancelled by the driver as proof that he is alert, but an attempt to forestall the warning by premature operation of the cancelling handle can only result in a brake application. When the cancelling handle has been used, a visual indication appears in front of the driver, and remains until it is reset to normal as the engine passes the next set of track apparatus. This valuable reminder is a feature of the London Midland and Scottish system, but is not available in the Great Western system.

In my opinion, the apparatus should do all that is required of it in accordance with the principles of warning control, and there should be no objection to the same footplate indication for the caution and danger indications of a multi-aspect signal, bearing in mind that automatic train control must always be regarded as an auxiliary to personal observation of the signals, and not as a substitute for it. The location of the track apparatus 200 yards before reaching the signal gives the necessary warning in good time, and in multi-aspect areas no driver, except in a sudden emergency, will encounter a signal at red without having received an audible warning for the yellow aspect of the signal at rear, of which he will be reminded by the cancellation indicator while he is running between the two signals. I consider that, from the safety point of view, there is no need for differentiation on the footplate between the yellow and double-yellow indications at a four-aspect signal.

Furthermore, from what the inspecting officers have seen of the latest prototype appratus, on the bench and on the road, it appears that the technical principles are satisfactory, and that detailed design has now reached a stage when any unforeseen troubles which may arise should be rectified without undue difficulty. It will, however, have to be very fully tested in day-to-day service before the Railway Executive can say that they are satisfied beyond any doubt on the complete integrity of design and construction. Trials with this object commenced in April this year with 54 engines, and the Executive feel that it will be necessary for them to be in full and normal service for at least six months, and that a final decision on the design for large-scale production cannot be taken until the results of the trials are assessed. In my view, the period may have to be longer, and thereafter further trials, and laboratory tests to destruction under severe vibration, may be necessary with the production design.

### ALTERNATIVE PLANS.

The British Transport Commission have now informed the Minister that, on hearing that I, as chief inspecting officer, am completely satisfied with the efficiency and reliability of the system, they will be prepared at once to consider financial authority for a practical programme of installation. The following are the Executive's proposals: (1) for a five-year plan at an estimated cost of 7·5*l*. millions, and (2) for a long-term plan which, including the five-year plan, would bring the estimated total cost to 17·3*l*. millions. The corresponding annual charges are estimated at 1*l*. million and 2·2*l*. millions.

The five-year plan (1) would cover 1,332 miles of route "or such part of it as may be deemed advisable" covering the lines from Euston to Glasgow, King's Cross to Edinburgh, Edinburgh to Glasgow, Euston to Birmingham, Manchester and Liverpool, Liverpool Street to Norwich, and Waterloo to Exeter, Southampton and Bournemouth. It is obviously desirable to avoid the dissipation of resources over too many routes at once, and, in consequence, the five-year plan would probably concentrate first of all on the main East and West Coast routes to Scotland. The route priorities proposed are essentially sound, and I refer later to the suggestion by the Commission that the five-year plan should be regarded as a maximum rate of progress having regard to other commitments of the signal engineer staff in new work and maintenance. The long term plan (2) would cover an additional 3,988 route miles or, including the five-year plan, a total of 5,320 route miles; on its completion, 6,713 route miles would have been covered by warning control of one type or another, including the 1,393 route miles of the Western Region and the London Tilbury and Southend section which are now equipped. These 6,713 route miles represent nearly 35 per cent. of the British Railways total (19,276 miles) and would include practically all the main lines carrying heavy passenger traffic. The existing proportion in the Western Region is very similar.

# CAR-FERRY TERMINAL AT DOVER.

FIG 1. GENERAL VIEW OF TERMINAL.

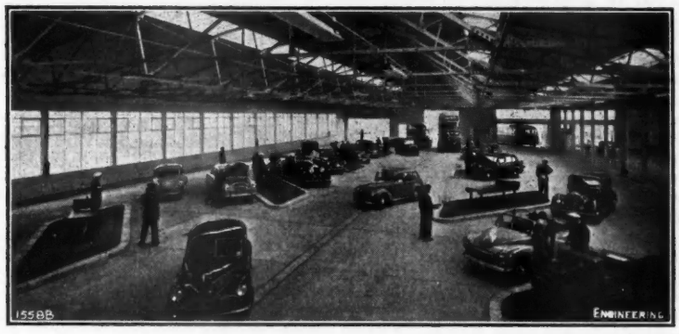


FIG. 2. CUSTOMS EXAMINATION BUILDING.

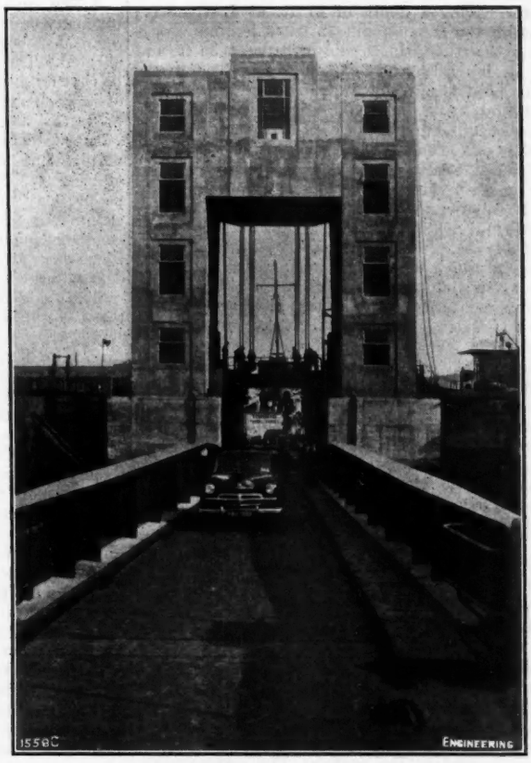


FIG. 3. LOADING BRIDGE AND PORTAL.

Thus, after all these years, there are now firm prospects that work will be started on the extension of warning control to all the important routes of the country within a measurable time, but it would be wrong for pressure to be exerted on the Commission or the Executive to embark on a very costly programme before the trials are completed to the satisfaction of all concerned.

There is thus no longer any need to urge the adoption of automatic train control as a standard feature of safety equipment, as is shown by the proposals which have been outlined by the British Transport Commission. They have, however, emphasised that while automatic train control deserves high priority among safety measures, it cannot be given absolute priority over other forms of signalling modernisation, such as the extension of track-circuiting and block controls to prevent mistakes by signalmen. Progress in this direction has been continuous in recent years, though circumstances have prevented the realisation of the comprehensive programme which was envisaged by the Railway Executive in 1948. As an example, the West Coast main line of the former London Midland and Scottish Railway, on which Harrow is situated, has been more thoroughly equipped with modern signalling controls than any other long-distance route in the country; these are one of the "indirect" methods of improving safety recommended by the 1927 Pringle Committee, and statistics confirm that they have been very effective.

This work must, of course, continue as a means of preventing accidents of a numerous class in proportion to the total against which automatic train control can provide no safeguard. Encouragement must also be given to the progressive replacement of semaphores and manual block by colour-light signals and continuous track-circuiting on lines where traffic is dense and at complicated layouts, as another of the indirect methods. Although these improvements are designed, in the main, to prevent signalmen's errors, colour lights, including colour-light distants in semaphore areas, have done much to help drivers, especially at night and in bad weather, and their number has been increased by 50 per cent. since 1948. Experience, however, has shown that they cannot by any means be regarded as an equivalent alternative to automatic train control.

The safety of railway operation depends on many factors, and besides modern signalling equipment they include a good track and soundly constructed and maintained rolling stock. The provision of automatic train control is only one of them, and the proportion of accidents which it can prevent is comparatively small, but they are of a type which can be disastrous to life and very costly to the administration, and therein lies its special value as a safeguard against the consequences of human failure.

In the regulation and execution of an automatic train control programme in relation to the many other calls on the signal department for new work and maintenance, much must be left to the judgment of the management. I do not, however, look on automatic train control as a competitor to other signalling development, but as complementary to it, as indeed was the view of the Railway Executive in 1948, when they recommended that a more extensive programme than that now proposed should be completed in six years, and that it should run concurrently with a programme of the same order for the extension of track curcuiting and block controls.

The very occasional failures which have occurred give no grounds for loss of confidence in British railway engine drivers as a whole, and there is no reason to believe that the problem has become more urgent in the last few years, notwithstanding the exceptionally tragic results of one such failure at Harrow.* All, however, are agreed that enginemen should be given their share of technical aids to safe working, and I consider that at this late state there should be no reservations on the rate of progress once the apparatus has been approved.

* Apart from the 112 persons who lost their lives at Harrow, only one passenger was killed in an accident to a train in 1952.

## CAR-FERRY TERMINAL AT DOVER.

ON Tuesday, June 30, the car-ferry terminal at the Eastern Docks, Dover, was opened by the Minister of Transport and Civil Aviation, the Right Hon. Alan Lennox-Boyd, M.P. The terminal, the first installation of its kind in this country, was planned and designed by the Dover Harbour Board immediately after the last war to provide the facilities required for the rapidly-expanding traffic of accompanied cars and coaches to and from the Continental ports served by Dover. The car traffic through the port, now more than three times that before the war, is approximately 100,000 vehicles a year.

Until now, vehicles have been handled by cranes, except at the train-ferry dock, which has been in use since 1936 and where cars proceeding to and from Dunkirk have made use of the direct-loading facilities of the train ferries. In general, the shore facilities were totally inadequate for handling car traffic and vehicles were subject to long delays before shipment or after discharge from the ferry. For the most part, this state of affairs was unavoidable, in that the dockside accommodation had never been intended for that particular type of traffic and was, in fact, unsuited for handling cars requiring ample manœuvring space. The new car-ferry terminal has been designed to overcome these difficulties and to be capable of handling all traffic envisaged for several years ahead. During the peak periods there will be seven arrivals at, and seven departures from, the terminal daily; the shipping available provides for a daily capacity of 500 vehicles.

The new terminal comprises a reception car-park for 300 cars and a 12-pump petrol station; a reception building for administration, post-office and banks, buffet, bar and waiting rooms; a customs examination building which can handle 240 cars per hour; a marshalling car-park for 300 cars; two loading berths equipped for stern loading of the ferries; and two lay-by berths. The arrangement is illustrated in the general view,

taken from the cliffs behind the harbour, shown in Fig. 1, on page 55.

The new loading berths have been constructed in water having a depth of 21 ft. at L.W.O.S.T.; each is 400 ft. long and 72 ft. wide, and vessels up to 400 ft. in length and of between 35 ft. and 55 ft. beam can be accommodated. The berths have been formed by widening the existing west jetty by 10 ft. and constructing two new jetties parallel to the first to enclose the berths. The new jetties each consist of a series of mass-concrete dolphins. Sheet piling was driven about 5 ft. into the chalk to form box cofferdams approximately 30 ft. square; the piling was then cut off 2 ft. 6 in. above L.W.O.S.T. After cleaning out the mud and soft chalk, the cofferdams were filled with mass concrete which was placed under water by tremie. Above the piling, the concrete was placed inside timber shuttering. The central jetty is composed of two isolated dolphins but the new eastern jetty is formed by three dolphins linked by steel foot-bridges. The leading dolphins to each jetty are each twice the size of the others and have been provided with a timber-and-rubber flexible fender system. At the shore end, five dolphins form the foundation of the steel-framed portals to the loading bridges, one of which is shown in Fig. 3. A 4-ton electric crane has been installed on the western jetty for discharging ships' stores, etc., and fuel oil, water and electricity supplies are available for both the berths. To assist docking in a high wind, a concrete screen is being erected along the western jetty, to save the ferries from being slewed against the dolphins.

Access from the shore to each loading berth is by a short concrete ramp leading from the marshalling car-park to the loading bridges, and by a short link span from the seaward end of the bridge to the ship's deck. The bridges, 140 ft. long and weighing 280 tons, are hinged at the land end and can be raised or lowered at the seaward end by hoists located in the portals. The arrangements allow the bridges to follow the level of the ferry as it moves with the tide or loading. Vessels can be loaded at all states of the tide, and, even with extreme tides, loading can proceed provided that the deck is between 6 ft. and 18 ft. 6 in. above water level.

The range of ordinary spring tides is 18 ft. 9 in., but for the purpose of design this figure has been increased to 22 ft.; the maximum movement of the seaward end of a bridge is therefore 34 ft. 6 in. The bridge and accessory gear are suspended inside the portals, and the dead loads are balanced by two counterweights in each wing of the portal. The live load is carried by the main winch, situated in the machine room immediately above either bridge. The control room is located in the building between the two portals. Hoisting and lowering can be carried out under manual control and, after the link span has been lowered on to the deck of the ship, the automatic control gear can be brought into operation. The automatic limit switches are beneath the link span and are actuated by variations in the inclination of the span itself so that control is effected by the level of the ship's deck. The towers of the portals reach 87 ft. above low-water level and 108 ft. above the chalk foundation.

The spacious customs examination building has 42,000 sq. ft. of covered floor area in two bays, with galvanised-steel roof trusses of 95-ft. span. The roof is sheeted with corrugated asbestos and lined with building boarding; ample roof glazing and fluorescent lighting have been provided. The reception building is a steel-framed structure clad in brick and concrete, with large windows in the modern style, which, from the main hall and buffet, afford clear views over the harbour. Similarly, the petrol service station also has a modern aspect, being a reinforced-concrete structure with a butterfly roof.

The engineering design was undertaken by the staff of the chief engineer to the Dover Harbour Board, Mr. J. W. Sutton, O.B.E., M.I.C.E., M.I.Mech.E., and the principal civil engineering contractors were Messrs. Mears Brothers (Contractors), Limited, 154, Sydenham-road, London, S.E.26, for whom Mr. W. D. Carter, M.I.C.E., A.M.I.Mech.E., was the engineer for the work.

## LABOUR NOTES.

A NEW round of very heavy wage claims, covering many branches of industry, appears to be pending. Most engineering and related trades will be affected. The largest single demand is likely to be that for an increase of 15 per cent. in the wages of adult men employed in all grades of manual work in engineering and shipbuilding establishments, put forward by the council of the Confederation of Shipbuilding and Engineering Unions at their meeting at York on May 20. Some 2,500,000 workpeople may ultimately be concerned in this one claim. A week later, it may be recalled, the Amalgamated Union of Foundry Workers, at its annual conference at Scarborough, passed a resolution demanding a new wage structure for the foundry trade, in addition to an increase of 15 per cent. in the wages of all foundry operatives.

A claim for an increase of 15 per cent. in the wages of railway employees was decided upon by the three principal railway unions last week, and presented to the Railway Executive last Friday. This claim covers the 600,000 members belonging to the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Transport Salaried Staffs' Association, and will apply to employees of London Transport Executive and the Hotels Executive, as well as to those of the Railway Executive. It is estimated that the claim, if granted in full, will cost about 20 million pounds in a full year.

Announcing the railwaymen's joint claim at a conference of representatives of the National Union of Railwaymen at Paignton, Devon, on Sunday last, Mr. J. S. Campbell, the general secretary of the N.U.R., stated that, if negotiations on the demand were protracted, it would be the policy of the unions, as always, to attempt to have some payment made, restrospectively, from the date that the claim was first submitted. He said that the claim had been put forward to bring the pay of railwaymen up to the level of that obtaining in industry generally, and to compensate for the advance in the cost of living.

There had been a considerable advance in living costs, Mr. Campbell affirmed, since the 7*s.*-a-week increase accepted by the railwaymen last November. Taking the interim index of retail prices as a standard, the average wage of employees throughout the country was five points below its proper level. In the case of railway employees, their wages lagged 16·1 points below the level at which they should stand. He pointed out that the unions were not entering a claim for an increase of 15 per cent. in the hope of obtaining 2½ per cent., but that they were as serious as they could be in their demand for the whole 15 per cent. Wages covered by the claim range from the lowest standard rate of 5*l.* 17*s.* a week for porters up to the minimum standard rate of about 8*l.* a week for other grades.

Warnings of the dangers which attend the present "catch-as-catch-can wage policy" were given by Mr. H. W. Franklin, the President of the N.U.R., in his address at the opening session of the union's annual conference at Paignton on Monday. He told the delegates that when the trade-union movement succeeded in achieving a turn of the wheel of the wage cycle, members tended to overlook that an inevitable result of the turn was an increase in the price of food and other commodities essential to the everyday life of the average man and woman. A new approach to the problem of stabilising wages, prices and profits was needed. No matter what Government was in power, trade unionists and others were faced with the indisputable fact that the country must export to live, and must balance its resources by its expenditure.

Only a wage pool, Mr. Franklin suggested, could calm the turbulence of constantly-changing wages and prices. He urged that such a pool should be formed by the Government and the Trades Union Congress approaching the subject together and deciding what sums should be used for wages and salaries. Stabilising the cost of living would also ease the burden of retired persons, who were forced to live on small fixed incomes. It was regrettable that a traditional outlook should preclude the matter being thoroughly examined by the trade-union side of industry. He was convinced of the futility of continuing to pass resolutions demanding more wages, well knowing that they would soon be swallowed up by increased costs.

The employees' side of the Railway Shopmen's National Council, it was announced on July 2, would submit a claim for a wage increase on behalf of railway shopmen at the Council's next meeting. Some 135,000 engineering operatives, employed in the railway workshops, are represented on the employees' side of the Council. They either belong to the National Union of Railwaymen or are affiliated to the Confederation of Shipbuilding and Engineering Unions. No specific amount has been mentioned, and it is expected that a demand will be put forward for a "substantial amount." The last increase granted to the railway shopmen was in March, 1952, when they received sums varying from 8*s.* to 9*s.* 6*d.* a week, ante-dated to September, 1951, under the terms of an award by the Industrial Court.

In the coal-mining industry, the problem of higher wages appears to have aroused in the men's leaders a growing feeling of concern at the possible impact on public opinion of the further rises in the price of coal, which would follow any successful demands by the miners for still larger pay packets. At a meeting of the executive council of the National Union of Mineworkers on July 3, in preparation for the opening of the union's annual conference at Hastings, on Monday last, it was decided to ask the delegates, at the first session, to approve of the debates on wages being held in private. The council also hoped, it was stated, that, as a result of these private debates, the whole matter would be left in their hands to determine what future action should be taken with respect to wage claims.

It had been apparent for some time that the campaign, jointly sponsored by the N.U.M. and the National Coal Board, in February last, with the object of promoting increased efficiency throughout the industry and a realisation of the urgent need for increasing production, had not been as fully successful as had been hoped by the two bodies. This had been borne out by the spate of motions submitted to the conference, demanding higher wages, larger pensions, increased sickness and disability benefits, and more amenities generally. Such motions were as numerous as in past years and likely to prove just as costly.

During the opening stages of the conference, however, it was obvious the men's leaders would make every effort to convince the delegates that fresh concenssions in wages and working conditions could only be obtained by giving in advance increased efficiency and larger outputs of coal. The main debates on wages, which were due to be discussed on Tuesday, were scheduled to take place on two resolutions. One, sponsored by the Kent area, requested, without any qualification whatever, that the union should press for a substantial increase in wages for all miners. The other, put forward by the Scottish area, urged that there should be an increase in the wages of all day-wage miners, to meet the rising cost of living, and to improve the men's standard of life generally.

Solemn warnings were given by Sir William Lawther, in his presidential address to the conference, that the two alternatives facing the mining industry in Britain were either to produce more coal or to accept a lower standard of life. He told the delegates that the only hope for the salvation of the country lay primarily in a prosperous coal industry. When the industry was nationalised, too many miners believed that the union had only to make demand after demand, without regard to the consequences. Yet in this country, as elsewhere, improvements in the status of the employees could only be had by making greater efforts at work.

# ENGINEERING INDUSTRIES OF SHEFFIELD.

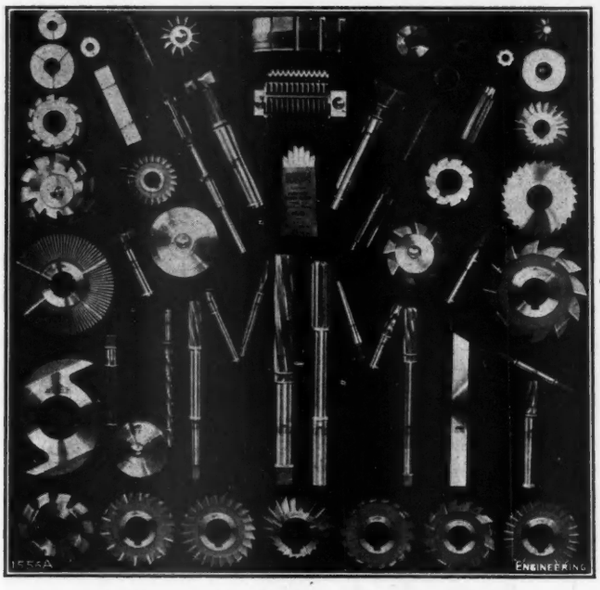

FIG. 1. SOME STANDARD ENGINEERS' TOOLS.

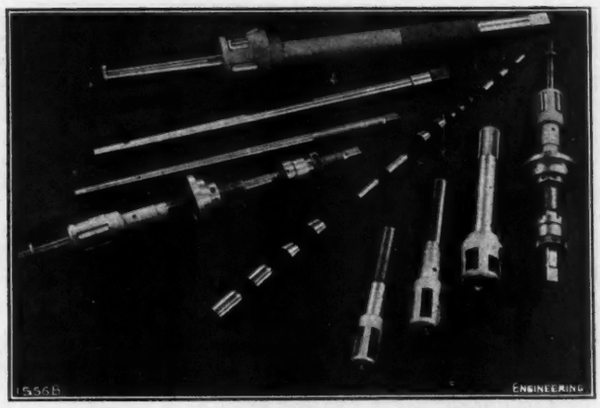

FIG. 2. SPECIAL-PURPOSE TOOLS: TUBE EXPANDERS FOR HIGH-TENSILE ALLOY TUBES.

## THE ENGINEERING INDUSTRIES OF SHEFFIELD.*

By M. A. FIENNES, M.I.Mech.E.

I BELIEVE it to be historically true that much of Sheffield's basic industry grew up around the five streams which conjoin in the River Don. Nobody to-day thinks of Sheffield as an industrial centre based on water-power, but the harnessing of the local waters in their rapid descent from the adjacent moors by means of the simple water-wheel was undoubtedly a primary influence on the rise of the steel-making and forging industry and also on that of the tool and cutlery trades.

The earliest known water-mill is said to have been built on the Blackburn Brook in 1141 by the monks of Ecclesfield Priory. Not all of the mills, however, were concerned with metallurgy. A general picture of early valley scenes in and around Sheffield is given by Justice Fitzherbert in his *Boke of Surveying* published in 1538, in which he said: "There be many manner of mills, corn mills, fulling mills, scythe mills, cutlers' mills, smith mills, and others as the wheel goeth by drift of water." These early water-wheels seem to have been used for a variety of trades, ranging from silk and cotton milling to snuff making, and from cloth fulling to steel forging by the tilt hammer. Much ingenuity and skilful design were employed to overcome the handicap of inadequate materials.

Mechanical engineering worthy of the name seems to date back in the Sheffield district some 150 to 175 years, but, as elsewhere, it received its main impetus from the factors which went to make the Industrial Revolution. Thus the pace of development quickened greatly around the 1830's and 1840's and several well-known engineering firms in the district have their origins in that period. The development of the steam engine and of rail transport, the opening up of the South Yorkshire coalfield and, above all, the successive inventions in modern steel-making were the foundation of most of the mechanical engineering in the neighbourhood. Much, indeed, of this original influence can be seen in the character of many Sheffield engineering concerns to this day.

It is said that the first locomotive to make the through journey to London from the North Midlands was built in Sheffield and carried the nameplate "Sheffield No. 6." Some very large fixed steam engines were built in these early days, operating on the low steam pressures then available. There are records of rolling-mill engines with cylinders 50-in. diameter by 54-in. stroke; colliery winding engines 72-in. diameter by 74-in. stroke; and beam pumping engines 72-in. diameter by 108-in. stroke. In the last quarter of the Nineteenth Century, however, much of Sheffield's engineering had begun to concentrate on the manipulation of steel. The steam hammer and the rolling mill were much in demand, and in 1887 a forging press having a power of 4,000 tons was built. It seems that posterity has been able to improve little upon its fundamental design and I leave you to judge whether that is a tribute to the past or a reflection on the present.

It would be agreeable to be able to trace a coherent sequence of events from those early days to Sheffield engineering as it is to-day, but life is rarely as tidy as that. Nevertheless, it is possible to discern a fairly clear outline of the way in which engineering in the district is linked to some of its basic trades. The traditional craft of working in fine silver and plate, for instance, established a local skill in the making of dies and of simple presses and stamps in which to use them. Thus, when steel came to be made in Sheffield, the cutlery industry had both its materials and its skill in tool-making ready to hand; and, when engineers' tool steels and, eventually, high-speed steels came to add fresh lustre to the city's name, it was only natural that the makers of those steels should themselves push forward the boundaries of their products and establish the manufacture of engineers' tools. For it is, perhaps, as the home of engineers' tools, along with special steels, cutlery and silverware, that Sheffield is most famous.

At least 75 per cent. of the total British manufacturing capacity for engineers' tools is centred in Sheffield. Production is characterised by an almost bewildering complexity and variety of types and applications. Tools, such as milling cutters, hobs, reamers, metal-slitting saws, side and face cutters, and a host of others, are produced in great quantity for machine use, while the range and diversity of hand tools is just as considerable.

Fig. 1 shows a few of the well-known standard types. While there is, of course, much standardisation in the manufacture of such equipment, the industry also caters for a wide variety of special designs. A large part of the milling-cutter trade, for example, lives by meeting the special requirements of the engineering industry. Plant engineering for the tool-making trade is thus a very specialised affair and many of the better-known tool-makers design and build their own machines or attachments for special purposes.

The manufacture of twist drills is largely concentrated in Sheffield. One company alone employs 1,000 people and four acres of productive floor space to produce around 1,000,000 twist drills a month, as well as a considerable output of reamers and end mills. It will be obvious that outputs of this order are only obtainable by a high degree of mechanisation, and production engineering in this trade has made notable advances in recent years.

Fig. 2 shows a set of tube expanders, specially designed in a Sheffield works for the oil industry. Here, the work of the metallurgist and the engineer were closely combined to produce an expander which would resist the extremely heavy pressures encountered in rolling high-tensile alloy tubes for refineries. A special expanding tap which was designed for tapping a hole where the diameter of the entry to the hole was slightly less than the portion to be threaded is shown in Fig. 3, on page 58. In this design the threads can be retracted for insertion and then expanded for cutting.

Perhaps the oldest engineers' tool of all is the file (Fig. 4, on page 58). I am told, though I have not verified it myself, that, in various primitive forms, files were made from the dried tail of a fish, such as a skate or a ray, while hand-cut flints were used for the same purpose. I am glad to be able to announce, however, that these methods have now been abandoned in Sheffield and that some 97 per cent. of the total British production of steel files is centred in the city.

The multiplicity of types is enormous. Some 500 or 600 different types of engineering files are regularly made, while the more specialised precision and needle files—originally a Swiss development—which serve the instrument, watch-making, radio, die-sinking and other comparable precision trades, are produced in something like 2,500 different forms. Some of these special-purpose files are productions of great delicacy, and such examples as contact-breaker files, made in special carburised material, are regularly produced with cuts as fine as 300 teeth per inch, even on files of maximum thickness of no more than 0·017 in. Even on the less intricate engineers' files, some 22 different operations are necessary in the cutting process. File-making to-day is a carefully controlled operation from the analysis of the special file steel right through to the finishing process.

Fig. 5, Plate XXVII, shows a silversmith working with a hacksaw. As with other tools, so with saws, the variety is enormous. A great volume of hacksaw blades and frames has been made in Sheffield for many years, ranging from saws 30 in. in length and 2½ in. wide, with four teeth to the inch, down to the extremely fine saws which are known in the trade as piercing saws. These are made in sizes down to 0·006 in. thick with 80 teeth to the inch, each one of the teeth being individually set. Saws of this type are so flexible that they can be tied in knots, despite the fact that they are still capable of cutting materials as hard as stainless steel.

The operation of tensioning a wide band-saw is shown in Fig. 7, Plate XXVII. Saw-making

* Address delivered at the Sheffield Summer Meeting of the Institution of Mechanical Engineers, on Wednesday, July 1, 1953. Abridged.

# ENGINEERING INDUSTRIES OF SHEFFIELD.

FIG. 3. EXPANDING TAP.

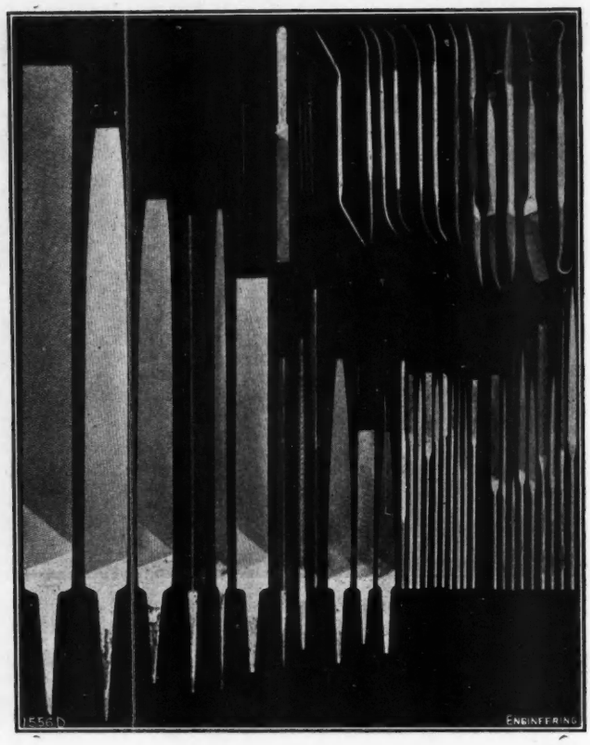

FIG. 4. A SELECTION OF FILES.

involves far more than the manufacture of a polished and toothed length of steel strip. It must be tensioned to enable it to stand up to the work. Tensioning consists of applying pressure to the body of the saw in such a way that the cutting edge is stiffened to prevent wavering in the cut. In the tensioning of large band-saws, as shown in Fig. 7, the object is to stiffen both the toothed edge and the back edge. For this operation, pressure is applied in the necessary places by a pair of convex power-driven rollers, in a tensioning machine. The decisions as to the amount of pressure and the places where it is to be applied rest solely with the highly-skilled saw-craftsman, who measures the progress of the work by means of a tension gauge. By raising a length of the saw and applying the gauge to its surface, the amount of droop, which is an indication of the tension of the edges, can be gauged with exactness, and the operation is continued, rolling and gauging alternately, until the full length of the saw has been treated. Saws of different degrees of tension are used for cutting different classes of wood and to meet the requirements of different users. Some of the wide band-saws, such as that shown in Fig. 7, are made in a nickel-alloy steel, in widths up to 14 in. and in lengths of over 100 ft.

Before leaving tool-making, reference must be made to Sheffield's part in the design and manufacture of precision measuring instruments, which are to-day so vital to the mechanical-engineering industries. I will not bewilder you by cataloguing the minute standards of accuracy to which these instruments are constructed; Fig. 6, Plate XXVII, shows a Vernier length gauge—an external and internal standard measuring gauge with screw adjustment to read to 0·001 in. and 0·02 mm. Micrometers are also made in Sheffield. Time does not permit a review of the wide range made, but I have selected the micrometer shown in Fig. 10, Plate XXVII, as being of special interest, since it is designed for the use of blind inspectors and its readings are in Braille.

In addition to the range of what are generally accepted as engineers' tools, Sheffield manufactures a colossal variety of other tools and implements. The number of types and classifications is almost beyond computation, but, as an example, it can be said that virtually all the wearing plates supplied to machinery for the agricultural industry are made in Sheffield. An important section of the Sheffield tool-making trade is concerned with the manufacture of machine knives. These knives might be described as the business end of numerous kinds of production machinery, for such purposes as veneer-making, woodworking, match-making, paper and board-making, carpet-making, tobacco and cigarette-making, sweet-making and packaging, and the shearing of steel in numerous forms. In this city, also, there are produced, daily and in thousands, edged tools for every conceivable application; tools for horticulture, for rail and road contractors, and for countless other trades; hammers of assorted types in almost astronomical quantities; spanners in similar diversity and profusion; and a great variety of surgical instruments—in fact, everything from the tools of a blacksmith to the equipment of a professional manicurist.

No survey of the lighter engineering in Sheffield would be complete without some reference to permanent magnets, the British production of which is for the most part centred in Sheffield. The enormous range of uses for permanent magnets cannot possibly find a place in this address, but those who have television sets may care to know that every set contains five permanent magnets of four different types. However, I advise them not to look for them.

Fig. 11, Plate XXVII, shows that most intriguing device, the magnetic floater, which is regularly saving much production time in many steel sheet-makers' works. It consists of a special permanent magnet devised for the automatic separation of iron and steel sheets and other comparable shapes. It works on the principle that permanent magnets of suitable strength are located opposite the edges of the workpieces, magnetising them by induction, similarly to one another, so that they repel one another. The top sheet actually floats in the air. This ingenious unit offers a solution to the difficulties so often experienced in separating and feeding a single article at a time and materially cuts down handling time on presses, guillotines and assembly lines.

In the manufacture of so many special types of tool, machine tools have been devised to produce them. Many have been made for their special purpose by the tool-makers themselves, but, at the same time and as a consequence, a machine-tool industry has grown up in Sheffield. In view of the work which is done on hardened steel, it is not surprising to find that this industry is largely concerned with grinding.

Fig. 8, Plate XXVII, shows a special die-grinding machine which works in conjunction with the forging rolls shown in Fig. 9. This machine is produced for the cutlery trade and is an electrically-powered set of blade-forging rolls, that is to say, a machine which takes a table blade blank and, by the introduction of specially-formed dies fitted into the machine's two work-rolls, produces a blade which is ready for grinding and finishing and which already possesses the double taper from bolster to tip and from cutting edge to back, both down the full length.

A heavy-duty high-precision surface grinder constructed for the form-grinding of lathe-bed slide-ways is shown in Fig. 12, Plate XXVII. This machine grinds parallel V-ways on the lathe bed to a tolerance of 0·00025 in. in 8 ft., and it is specified to produce this tolerance on beds on which the hardness is purposely varied from 300 Brinell to 530 Brinell. These machines are also used regularly for grinding lathe beds up to 12 ft. long with both V and flat slide-ways, and having tolerances of the order of 0·0005 in. over the total length, the job being done in some 35 minutes from the original planed bed condition. The corresponding job by the old hand-scraping method would have taken four days.

Situated as the city is in the centre of one of the most important coal-mining districts in Great Britain, and close to iron-ore mining and to quarrying on a very considerable scale, it is natural that Sheffield should have developed some part of its engineering industry for mining and quarrying machinery. This plant and machinery covers a considerable range. Fig. 13, Plate XXVIII, shows

# ENGINEERING INDUSTRIES OF SHEFFIELD.

(*For Description, see Page* 57.)

FIG. 5. SILVERSMITH USING PIERCING SAW.

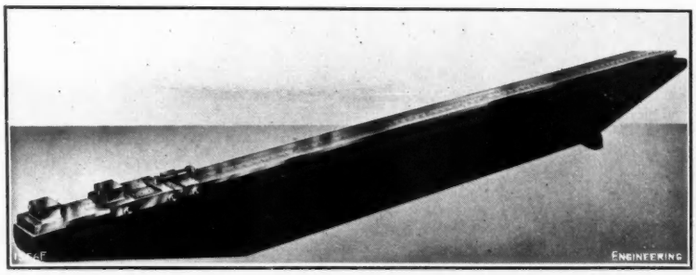


FIG. 6. MASTER PRECISION MEASURING INSTRUMENT.

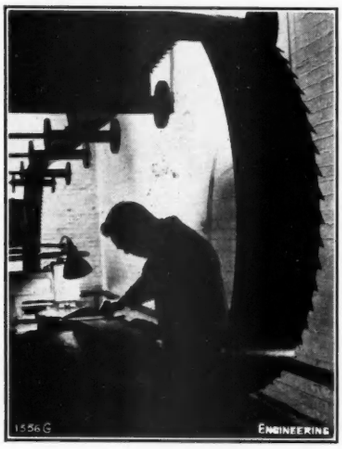


FIG. 7. TENSIONING WIDE BAND-SAW.

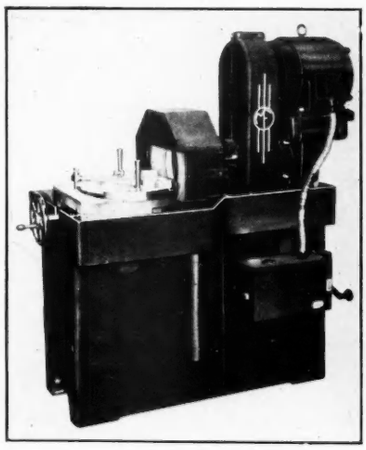

FIG. 8. DIE-GRINDING MACHINE.

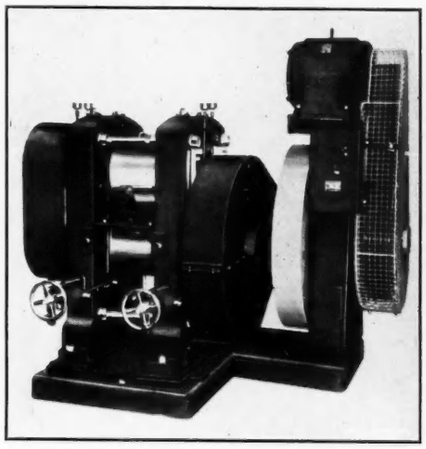

FIG. 9. BLADE-FORGING ROLLS.

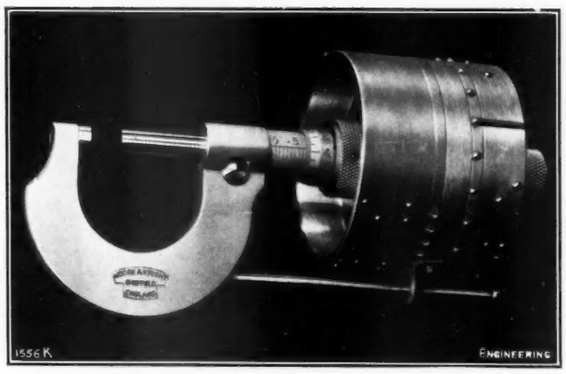


FIG. 10. BRAILLE MICROMETER.

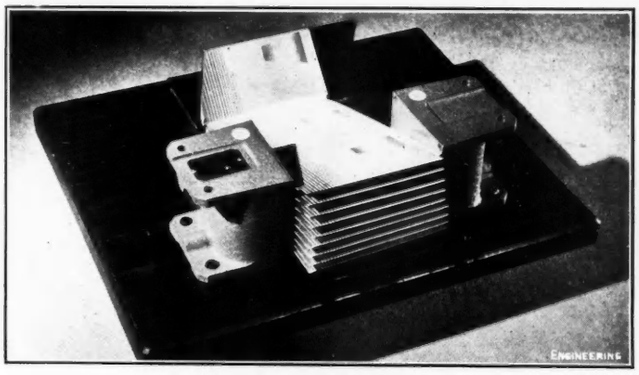


FIG. 11. MAGNETIC "FLOATER" FOR SEPARATING FERROUS SHEETS.

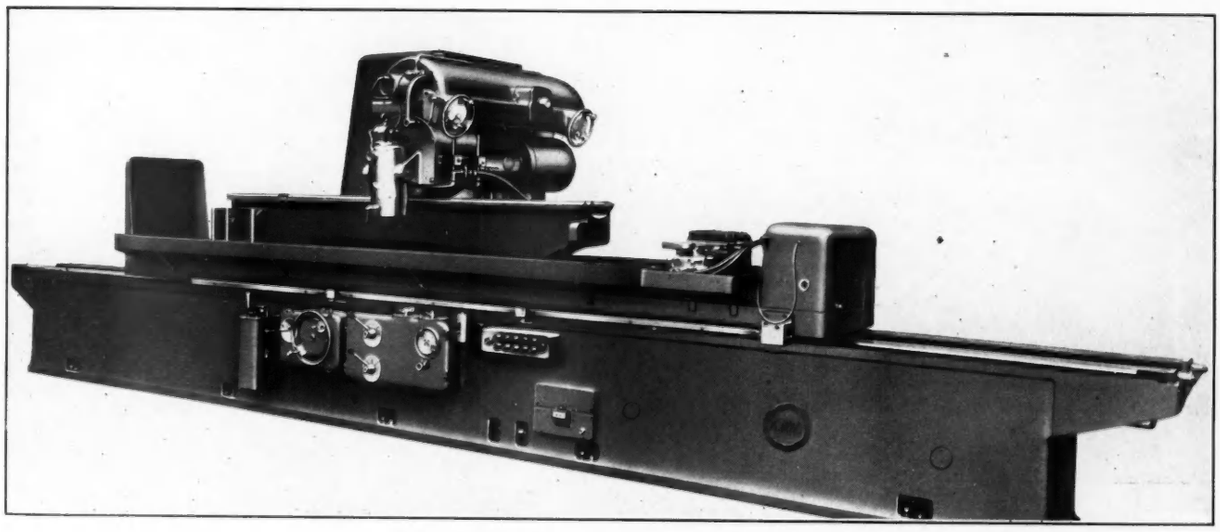

FIG. 12. HEAVY-DUTY PRECISION SURFACE GRINDER.

(*To face page* 58.)

# ENGINEERING INDUSTRIES OF SHEFFIELD.

(*For Description, see Page* 57.)

FIG. 13. 5-H.P. ELECTRIC DRIFTING DRILL.

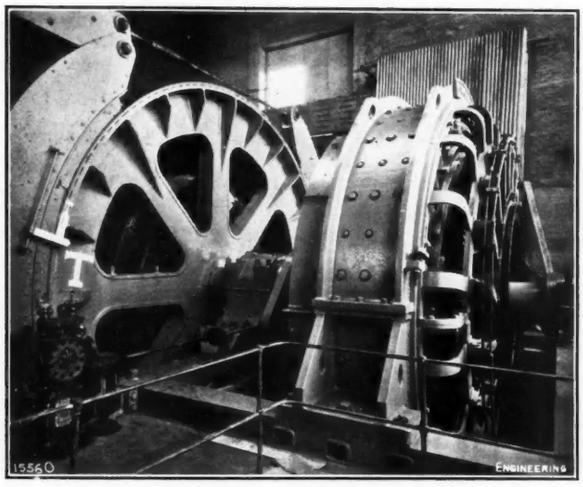

FIG. 14. LARGE COLLIERY WINDER.

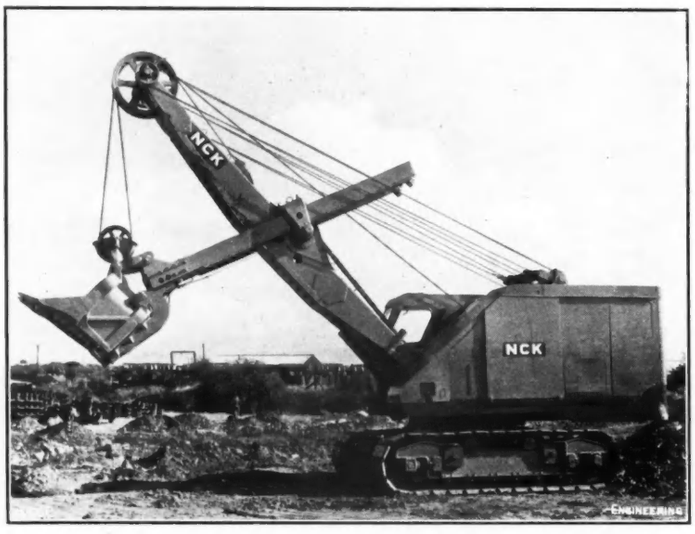


FIG. 15. 1½-CUB. YD. DIESEL EXCAVATOR.

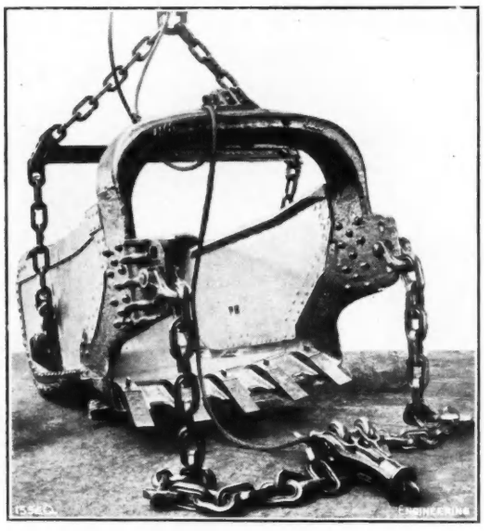

FIG. 16. 12-CUB. YD. DRAGLINE BUCKET.

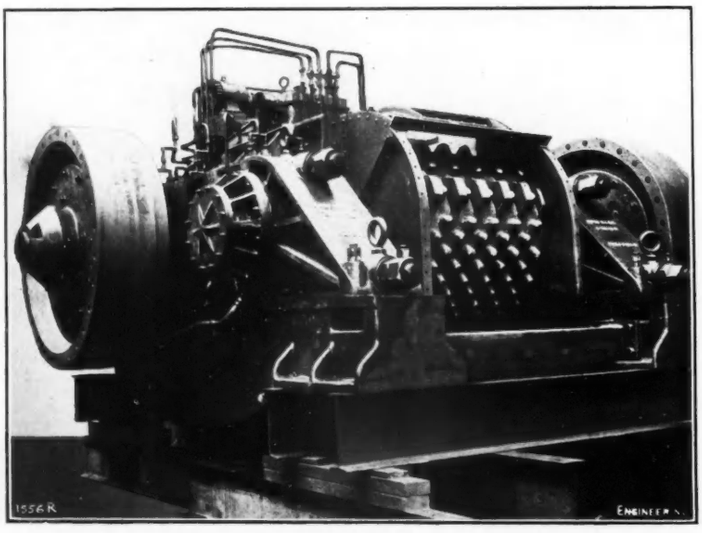

FIG. 17. CRUSHING ROLLS FOR IRONSTONE.

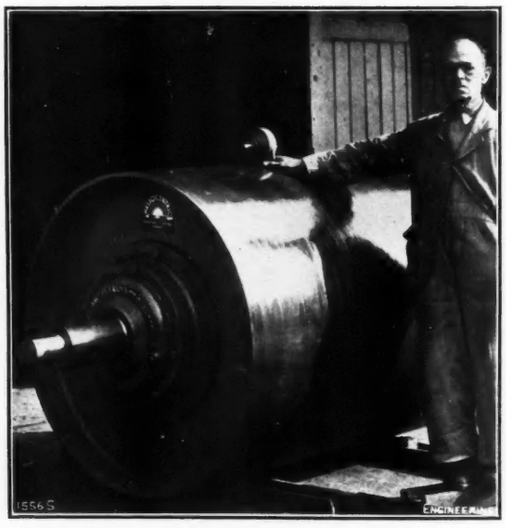

FIG. 18. CONVEYOR DRUM UNIT.

# ENGINEERING INDUSTRIES OF SHEFFIELD.

(*For Description, see Page* 57.)

FIG. 19. PRESS PART OF MACHINE FOR MAKING FINE PAPER.

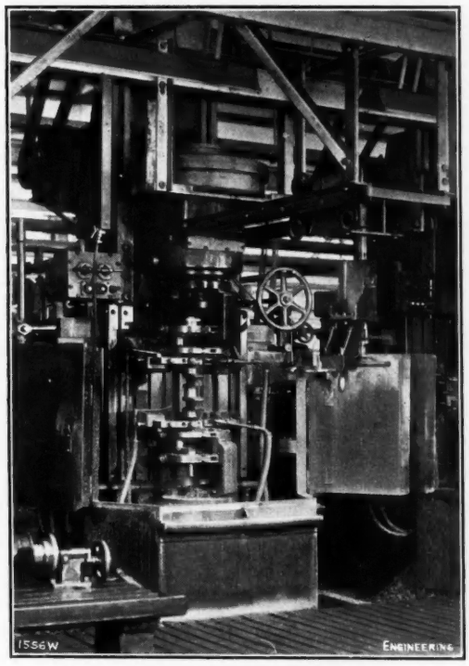


FIG. 22. VERTICAL CRANKPIN-TURNING MACHINE.

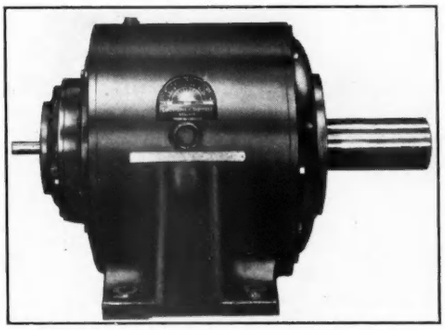

FIG. 20. HELIOCENTRIC SPEED-REDUCING GEAR.

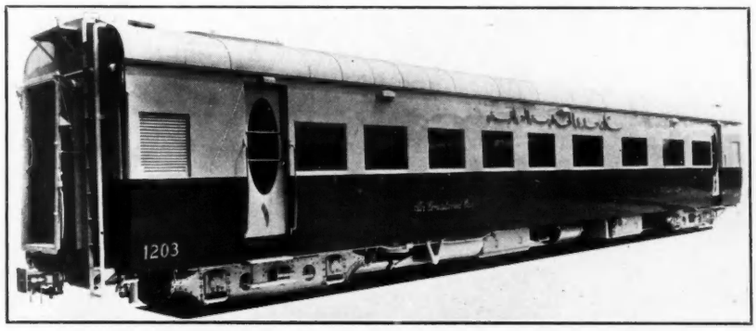


FIG 23 LUXURY AIR-CONDITIONED COACH.

FIG. 21. VALVE-SPRING MACHINE.

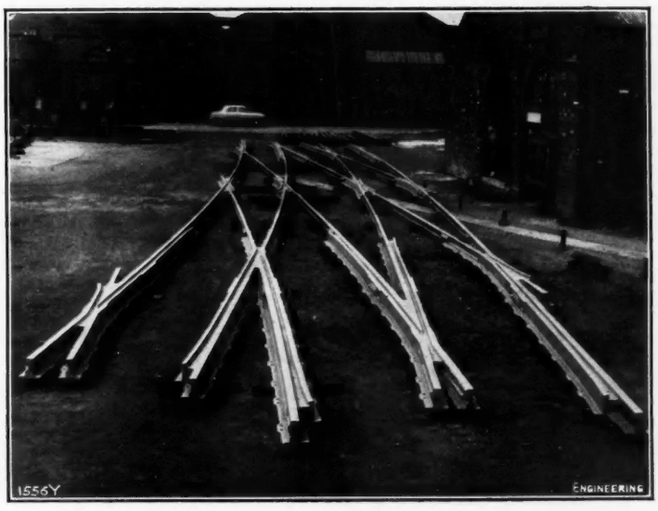


FIG. 24. SPECIAL CAST-STEEL RAILWAY CROSSING LAYOUT.

# ENGINEERING INDUSTRIES OF SHEFFIELD.

(*For Description, see Page* 57.)

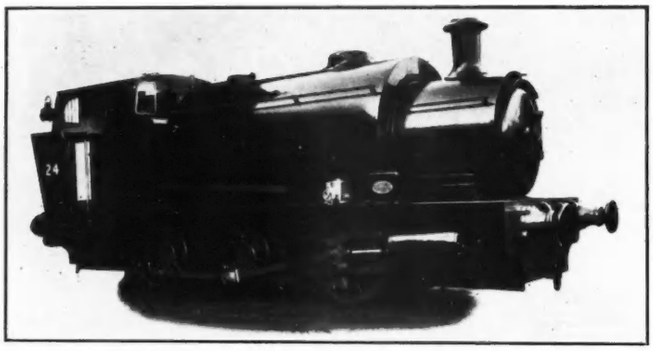

FIG. 25. INDUSTRIAL SADDLE-TANK LOCOMOTIVE.

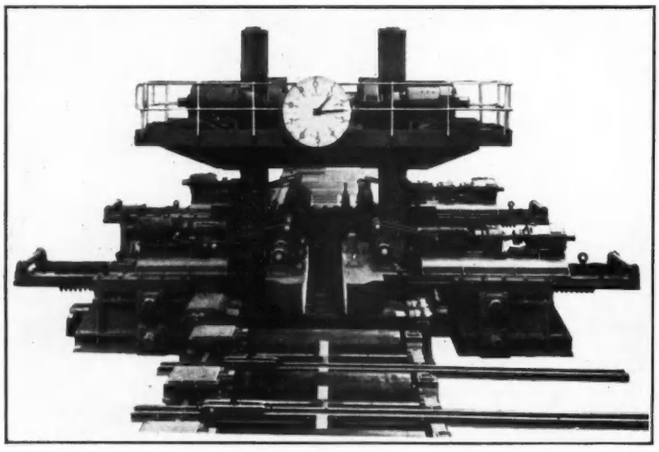

FIG. 26. REVERSING BLOOMING MILL FOR ALLOY STEELS.

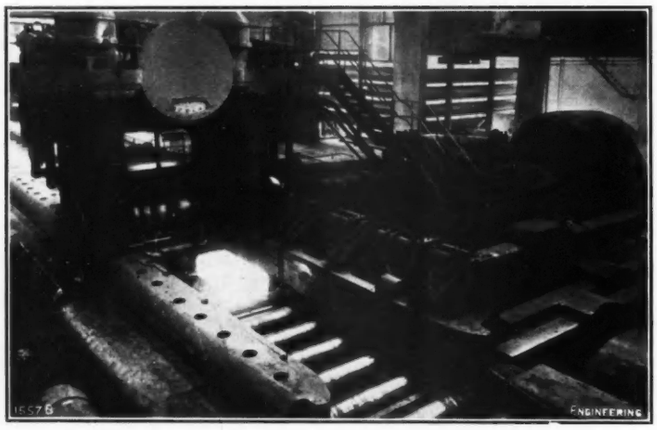


FIG. 27. REVERSING BLOOMING MILL (WHOLE LAYOUT).

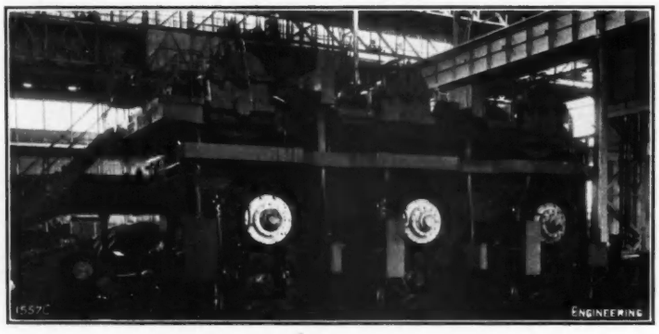


FIG. 28. COLD STRIP MILL FOR STEEL.

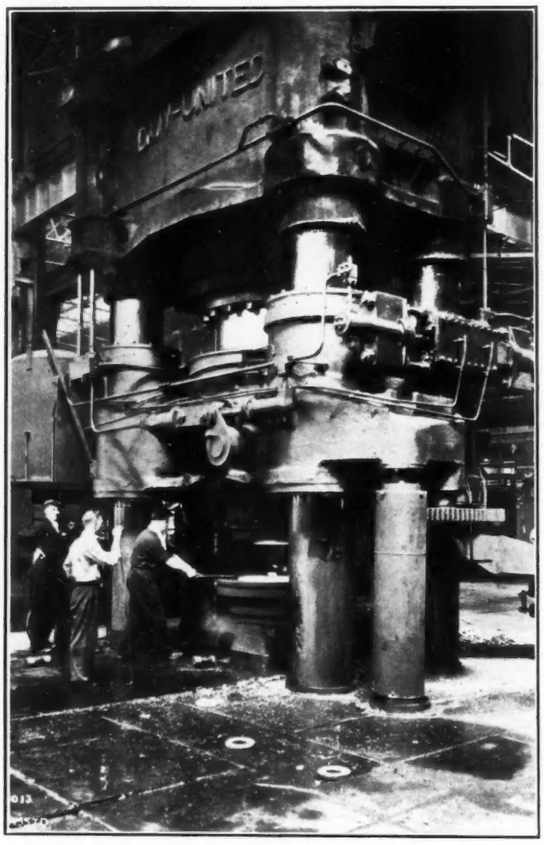

FIG. 29. 6,000-TON WHEEL-FORGING PRESS.

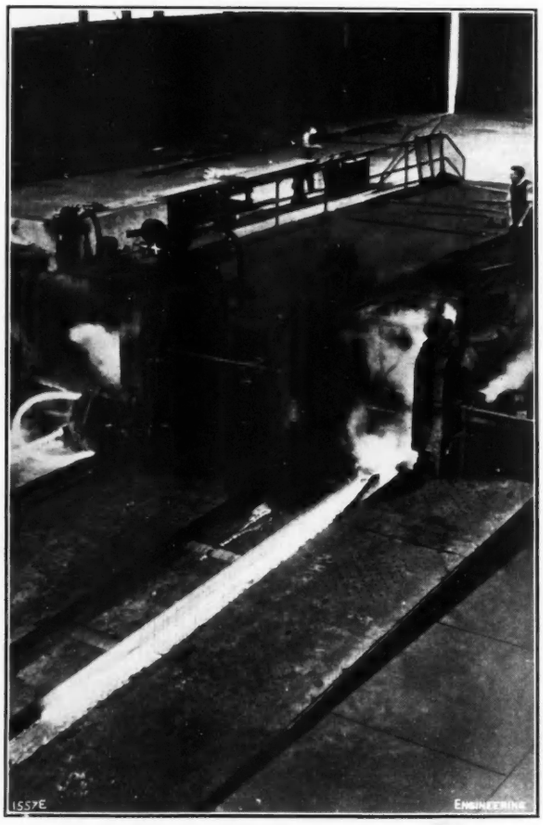


FIG. 30. TWO-STAND 16-IN. ROUGHING MILL.

(*To face page* 59.)

an electric rotary drill mounted on a special rig consisting of an elevating jib on tracks. This drifter has considerable advantages over percussive drilling, where the conditions are suitable, and it is used particularly in hard shale or sandstone. It is designed for the use of tungsten-carbide drilling bits and, in a recent test in a heading of hard and medium sandstone, it drilled 6-ft. shot-holes, aggregating 198 ft., in a total time of 133 minutes, which included the time taken for retraction of the drill and for the rod-changing and machine-moving.

Fig. 14, Plate XXVIII, shows a large colliery winder of 3,800 h.p. built in the Sheffield district. This machine is designed for winding 7 tons of coal at an output of 462 tons per hour. The depth of wind is 1,500 ft. and the full-lift winding time is a mere 42½ seconds. One of a range of excavators made near Sheffield, of the well-known type used in open-cast mining, quarrying, and contracting, is shown in Fig. 15, Plate XXVIII.

In Fig. 16, Plate XXVIII, is shown a dragline bucket of a capacity of 12 cub. yd. It is constructed largely in manganese steel, which had its birthplace in Sheffield and which is recognised as the only suitable material for standing up to the severely abrasive conditions of this application. The discovery and development of manganese steel in the city is another instance where the producers of a material decided to further its application in terms of machinery.

The high-speed heavy-duty iron-ore crushing rolls shown in Fig. 17, Plate XXVIII, are capable of crushing upwards of 500 tons an hour. The character of some kinds of ironstone demands crushing machinery of unusual type, primarily owing to the sticky and somewhat plastic nature of the ore. A machine of this type is an outstanding example of the case where the metallurgical knowledge of the steel-maker must be allied to the design experience of the engineer. Machines of this type have been known to crush over 1,000,000 tons of ironstone with no perceptible wear on the teeth of the roll shells of specially-treated alloy steel.

The range of crushing machinery made by Sheffield firms includes also jaw crushers of the largest type and the eccentric type of gyratory crusher. Similarly, the availability of hard abrasion-resisting steels has led to the manufacture in Sheffield of a great weight of specialised machinery, including combination tube mills, centrifugal slurry pumps, rotary kilns and coolers, coal-grinding mills, slurry mixers, and other machinery employed particularly in the cement industry.

Fig. 18, Plate XXVIII, shows a mining-conveyor driving-drum within which is mounted a heliocentric speed-reducer—a speciality of a well-known Sheffield firm. The sturdy Yorkshireman alongside is holding a baby version of this reducer on top. These interesting transmission units find a wide application in all sorts of industries where high reduction ratios are required in confined spaces, including integral constructions as shown. They can be supplied in fully-motorised form.

The two-stage 1-h.p. unit shown in Fig. 20, Plate XXIX, has a reduction ratio of 2,800 : 1, develops an output torque of 260,000 lb. in., and yet has an overall length inclusive of shafts of no more than 3 ft. 6 in. The particular unit shown is part of a plant which extracts oil from ground-nut kernels by methods allowing the protein in the residual meal to be used for the production of special wool-like fibre for use in textile manufacture.

Paper-making machinery is a fairly new development in Sheffield, but Fig. 19, Plate XXIX, shows the press part of a complete fine-paper-making machine producing fine writing and printing papers up to a trimmed width of 132 in. at a speed of 900 ft. per minute.

From the making of fine paper it is no great step to sticking labels on bottles containing fine liquids. Bottle-labelling machines can be supplied with a standard variable-speed output of from 2,400 to 10,200 bottles an hour. I understand that a machine of this type has been successfully sold to the United States against a specification that it shall put tight foil labels completely round cosmetic jars, so that the two ends of the label shall be perfectly in register, and that it shall carry out the operation at a specified speed of 120 jars a minute. It is stated that the machine has electronic proximity control, but I am reliably informed that this quality is not transmitted to the contents of the cosmetic jars.

Springs of all kinds have been a traditional Sheffield industry for many years. In light coil springs, Sheffield's output is easily the biggest in Britain. One firm alone has capacity for 100,000 springs a day for office machinery, and 75 per cent. of all the coil springs for the British motor industry are made in Sheffield. The production of valve springs, some of which are finished to limits of 0·001 in., is illustrated in Fig. 21, Plate XXIX. Independent front-wheel suspension systems have recently enlarged considerably the field of application of coil springs. Laminated or leaf springs are also made in large quantities and both types are supplied not only to the motor industries, but also to the railways of the world.

This leads to the engineering work which Sheffield does for the transport industry. Crankshafts, for example, are made in vast quantities. Two of the largest British producers of crankshafts are located in the city and, in a fine production layout, one of these produces from the billet to the finished crankshaft at an output of the order of some 6,000 crankshafts a week. Fig. 22, Plate XXIX, shows a vertical crankpin-turning machine specially developed for this purpose by the firm concerned.

Another company specialises in components and transmission units for the motor industry. An interesting example is an overdrive unit which is now optional on two well-known makes of British motor car and which has been designed to correspond with the conditions for which British motor cars are designed. The unit embodies a compound epicyclic gear working in conjunction with a hydraulically-controlled dual-purpose cone-clutch. The same company manufactures propeller shafts and universal-joint coupling assemblies and numerous other automotive units. It also makes garage equipment, such as small hydraulic presses and car-washing plant.

Also in the transport group, railway rolling-stock is made in the city. Fig. 23, Plate XXIX, shows one of a set of luxury air-conditioned coaches supplied recently to the Iraqi State Railways. These all-steel cars are suitable for day or night travelling, are sumptuously equipped and cost approximately three times as much as our own railways are in the habit of paying. A complete electric passenger-train unit built by the same Sheffield builder for the Estoril Railway in Portugal is designed for overhead-wire transmission with a line voltage of 1,500 volts, using four 140-h.p. 750-volt electric motors. It provides first and second-class accommodation in an overall length of 65 ft. It should also be mentioned at this point that motor units for this type of stock are built in considerable numbers in Sheffield in the electric-traction motor works of a famous British electrical company. Sheffield therefore builds carriages and wagons, their bodies, the wheels and axles on which they run, the springs on which they ride, the couplings by which they are pulled and the buffers by which they are checked.

Not only this, but also the track on which they run is made in Sheffield, as typified by the cast-steel railway crossing shown in Fig. 24, Plate XXIX. The engineering of such railway track-work is carried on by at least three Sheffield companies. Nor is the original tractive effort, in the shape of the locomotive, overlooked; Sheffield builds a range from industrial shunting engines to main-line passenger locomotives. Fig. 25, Plate XXX, shows an industrial steam shunting engine of the 0-6-0 saddle-tank type.

The reference to railway transport brings me back to the point where I began, namely, to the development in Sheffield of machinery for manipulating steel, and the heavy engineering to which this has led. Fig. 29, Plate XXX, shows a 6,000-ton hydraulic forging press designed and built by a Sheffield firm and installed in the Sheffield district for the high-speed forging of railway wheels. The press itself is characterised by the range of hydraulic tool and workpiece-manipulating equipment, some of which can be seen in the figure. It delivers formed wheel-blanks to the following tyre-rolling mill and the press is operated by three-throw electrically-driven hydraulic pumps operating at a pressure of 3,000 lb. per square inch through air-loaded accumulators; this pressure can be increased to 6,000 lb. per square inch by means of a hydraulic intensifier.

Fig. 26, Plate XXX, shows a 28-in. two-high reversing blooming mill for alloy steels, built and constructed entirely in Sheffield. Fig. 30, Plate XXX, shows a 16-in. three-high two-stand roughing mill, part of a large installation built for the rolling of sash bars. This particular illustration gives an indication of the ingenious double repeater employed.

In Fig. 27, Plate XXX, is shown a 42-in. reversing blooming mill built recently, which is driven by a 6,500-h.p. motor and is operating in conjunction with a section mill. The 80-in. three-stand tandem cold strip mill shown in Fig. 28, Plate XXX, is installed at the Abbey Works of the Steel Company of Wales. It was designed and built entirely in Sheffield and is, perhaps, the most modern of its type in the world. The housings of each stand are single-piece steel castings each weighing approximately 100 tons. The total combined power of the motors driving the mill is 12,000 h.p. The mill rolls steel strip in coils up to 74 in. wide for automobile body sheet and similar purposes, from approximately 0·110 in. thick to 0·035 in. thick, at a delivery speed of 2,035 ft. per minute. The roll-shearing force on each stand is about 2,000 tons.

That completes the lightning tour around the engineering industries of Sheffield in which you have been good enough to accompany me. You will see that much of our product is tailor-made to meet the requirements of particular applications. The special job rather than the mass-produced standard article is in general our strong suit. We believe we are known, above all, for the high quality of our material and for the high skill and craftsmanship with which it is converted.

Some 38,000 people are employed in Sheffield and district on engineering of one kind or another and no review would be complete without a tribute to their labours, to their craft and to their skill. I was looking the other day through an advertising pamphlet of an old-established firm of Sheffield engineers published more than 50 years ago. With that reticence for which we are so well known, the advertiser laconically extols the virtues of his machines. In sudden effulgence he bursts from ornamental body type into the full flower of block capitals and declares with finality: "People say: 'THEY ARE ALL RIGHT'."

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Acknowledgment is made to the following firms for the use of photographs: Joseph Thompson (Sheffield), Ltd. (Fig. 1); Samuel Osborn and Co., Ltd. (Figs. 2 and 3); John Bedford and Sons, Ltd. (Fig. 4); James Neill and Co. (Sheffield), Ltd. (Figs. 5 and 11); James Chesterman and Co., Ltd. (Fig. 6); Sanderson Bros. and Newbould, Ltd. (Figs. 7 and 20); Morgan Fairest, Ltd. (Figs. 8 and 9); Moore and Wright (Sheffield), Ltd. (Fig. 10); Snow and Co., Ltd. (Fig. 12); Hardypick, Ltd. and United Steel Companies, Ltd. (Fig. 13); Markham and Co., Ltd. (Fig. 14); Newton Chambers and Co., Ltd. (Fig. 15); Hadfields, Ltd. (Figs. 16 and 17); Edgar Allen and Co., Ltd. (Figs. 18 and 24); Millspaugh, Ltd. (Fig. 19); Tempered Spring Co., Ltd. (Fig. 21); Ambrose Shardlow and Co., Ltd., and the *Automobile Engineer* (Fig. 22); Cravens Railway Carriage and Wagon Co., Ltd. (Fig. 23); Yorkshire Engine Co., Ltd. (Fig. 25); Brightside Foundry and Engineering Co., Ltd. (Figs. 26 and 30); Davy and United Engineering Co., Ltd. (Figs. 27, 28 and 29).

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WORKS SERVICING TACKLE.—Chamberlain Industries, Ltd., Staffa-road, Leyton, London, E.10, have introduced a hydraulic jacking kit which is suitable for use on a wide variety of general maintenance and construction tasks in engineering shops and yards. It consists of a 5-ton hydraulic ram, a hand-operated pump, a flexible high-pressure hose, 7 ft. long, and various jacking pads, wrenches, grips and chain slings. The whole tackle is packed in a metal chest.

## VIBRATORY SOIL COMPACTOR.

THE vibratory soil compactor shown in the accompanying illustration has been designed for compacting road and railway embankments, backfill to trenches, earth dams, and the sub-grades below roads, runways, floors and foundations. It is a product of the Swedish company, A.-B. Vibro-Verken, Luntmakargatan, 29, Stockholm, 3, and is being distributed in the United Kingdom by Acrow (Engineers), Limited, South Wharf, London, W.2.

The soil compactor has a solid vibrating baseplate which is in direct contact with the ground to be compacted. The vibrating unit, which is hinged above the baseplate, contains two eccentrics which rotate in opposite directions at a frequency of 950 r.p.m., to give a combined centrifugal force of about 9,000 lb. By turning the vibrating unit about its horizontal hinge—an operation that is controlled by the steering wheel mounted on the column at the rear of the machine—it is possible to incline the direction of the resultant out-of-balance force so that the compactor is given either a backward or forward motion. Under its own power, the compactor can reach a speed of between 20 ft. and 35 ft. per minute, according to the nature of the ground being traversed. Power is provided by a Diesel engine with a rated output of 10 h.p. The total deadweight of the machine is about 3,000 lb.

The compactor is stated to have given good results in comparison with other types of soil-compacting machines. The depth of effective penetration varies with the ground concerns but under good conditions has been found to be as much as 40 in.—a depth exceeding that which can be achieved by rolling. Experiment has shown that, when moving under its own power and therefore at a somewhat restricted speed, little extra compaction is achieved by making a second pass. On the basis of two passes, however, the compactor has a capacity of between 1,000 and 2,000 sq. ft. of ground surface per hour. Due to the close control that can be maintained on the movement of the machine, it can be used in areas of limited space, for example, close to footings or to sheet piling.

For compacting large unrestricted areas, it is advantageous to tow the soil compactor behind a crawler tractor. In these circumstances, the capacity of the compactor is much greater than that of the self-propelled machine, although extra passes of the ground are necessary to obtain the same degree of compaction. In a compaction test made with and without towing, the capacity of the machine was found to be increased fourfold for the same degree of compaction. When soil compaction is carried out correctly, future settlement is virtually eliminated, the load-bearing capacity of the surface is increased, permeability is diminished and the homogeneity of the soil is markedly improved.

For the general transport of the compactor, the baseplate is fitted with two stub axles to which rubber-tyred wheels can be attached, so that the machine can be towed behind a lorry. The baseplate of the compactor is then locked rigidly to the engine base by four bolts; the speed, at such times, should be restricted to 20 m.p.h.

## TESTS FOR STABILISED SOILS.

PARTICULARLY since the end of the last war, the practice of stabilising soils has come into extensive use and the methods involved have been the subject of a great deal of trial and error as well as of much experiment. The injection of aqueous solutions of chemicals, which reacted and deposited insoluble salts that combined with surrounding sub-soil to form a conglomerate, was used before the war on constructional sites. The extensive use of soil stabilisation—at least, in the form in which it now finds its widest application, in roadmaking—probably did not commence until the early part of the war, when it was found to be a feasible proposition to stiffen the natural terrain of the desert or of clearings in the jungle to provide advanced landing strips for fighter aircraft. From this early stage, the process developed and was adapted for strengthening sub-grades below the heavy concrete pavements required for the ever-increasing weight of bomber aircraft.

With the cessation of war, the stabilisation of soils became even more widely used: first, in civilian airport construction, as well as for military airfields, and later for road-making generally. Both in the urban (and suburban) areas of densely-populated countries, and in parts of Africa and the Far East, the practice of soil stabilisation is providing a means of constructing road surfaces at a relatively low cost—the bulk of the material used being the virgin soil along the line of the road. Latterly, other applications have been developed, such as the strengthening of the formations below railway track and the improvement of embankments. As before the war, such methods continue to be used on constructional sites, particularly when placing heavy foundations, sinking shafts or driving tunnels through poor ground.

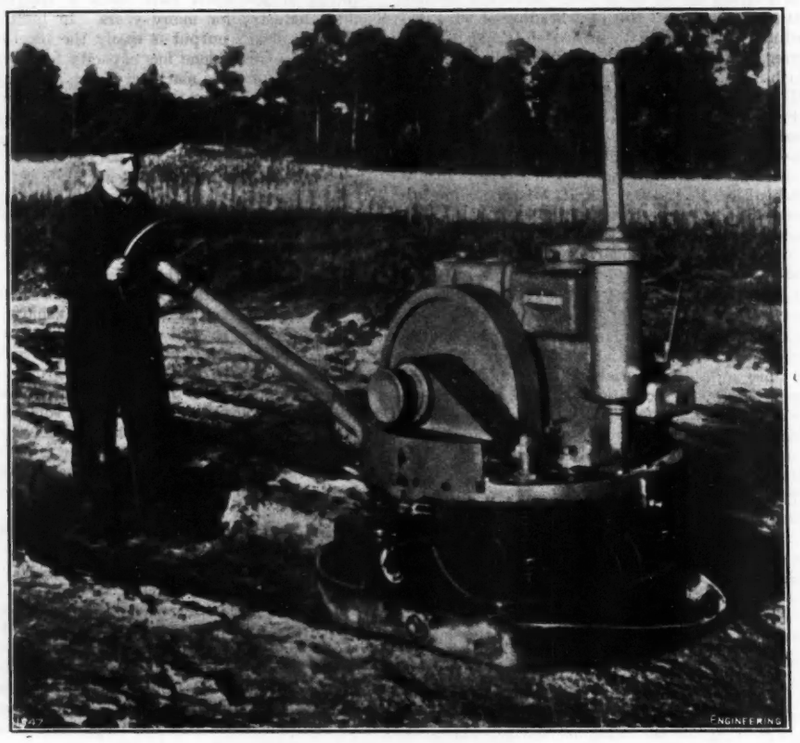
The amount of work of this nature that is being undertaken, in conjunction with the facts that the most economical results are achieved if materials are correctly selected and if experience gained on one site is accurately reported for use at another, has prompted the standardisation of the methods employed for testing soils that are to be, or have been, treated with stabilising materials. A new British Standard* forms a basic manual of instruction on the laboratory and field tests that are available for determining the properties of soils. Each test is fully described, all the equipment and materials that will be required are catalogued, and often illustrated, and an appendix gives typical forms for recording the results, making the necessary calculations and, finally, reporting the tests. Notes are also given on the initial preparation of the specimens.

For the purpose of the Standard, soils are regarded as all earthy materials that pass through a 2½-in. B.S. sieve, and they are then grouped under the three headings of fine, medium and coarse grain. For each of these groupings, details are given of the following tests: the determination of moisture content, the determination of the variation in the dry density of the solids in the soil when compacted at differing moisture contents, the measurement of the dry density, the unconfined compressive strength, and the cylinder-penetration test. The last mentioned test replaces, in part, the well-known determination of the California bearing ratio. It is intended to give a measure of the stability of stabilised soils but is not intended to be used in conjunction with curves for the design of pavements. The specimens, after being compacted in moulds, are wax-coated and then allowed to cure for seven days; the specimens are not soaked (as for the determination of the C.B.R.) and the result of the test is based on the penetration of a standard cylinder to a depth of 0·1 in.

* B.S. 1924: 1953. "Methods of Test for Stabilised Soils." British Standards Institution, 24, Victoria-street, London, S.W.1. [Price 12s. 6d.]

## VIBRATORY SOIL COMPACTOR.

A.-B. VIBRO-VERKEN, STOCKHOLM, SWEDEN.

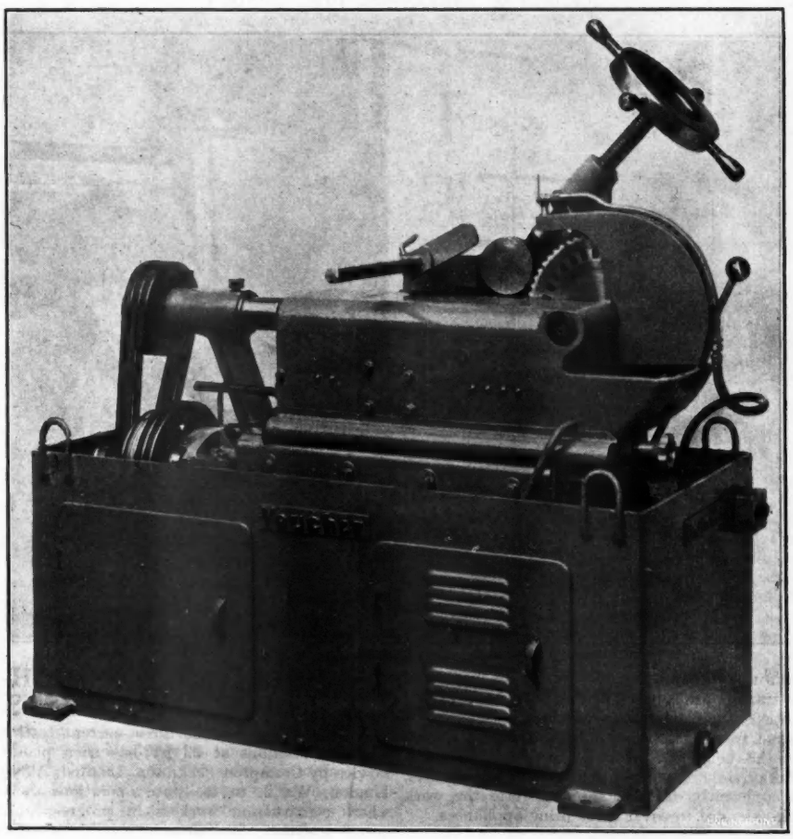



INDIAN INSTITUTE OF TECHNOLOGY.—The Indian Institute of Technology is to be opened at Kharagpur, West Bengal, during this month. The Institute, to be run on similar lines to the Massachusetts Institute of Technology, has five civil-engineering laboratories and will train engineers needed for the irrigation projects of India's five-year economic development plan.

THE LATE MR. T. CARTER.—We regret to record the death of Mr. Thomas Carter, which occurred on Tuesday, June 16, at the age of 76. Mr. Carter was born in Berwick-on-Tweed and educated at George Watson's School and the Heriot-Watt College, Edinburgh, as well as in Germany. He was engaged for many years with Messrs. J. H. Holmes and Co., Newcastle-on-Tyne, and was their chief engineer when he joined Messrs. A. Reyrolle & Co., Ltd., about 25 years ago. He was acting in a consultant capacity to the latter firm at the time of his death. Mr. Carter was elected a member of the Institution of Civil Engineers in 1918. He became an associate of the Institution of Electrical Engineers in 1902, an associate member in 1903 and a member in 1918. He had served as chairman and honorary treasurer of the North-Eastern Centre. He was also a Fellow of the American Institute of Electrical Engineers, and played an active part in the work of the British Electrical and Allied Manufacturers' Association, the British Electrical Research Association and the British Standards Institution.

## COLD-SAWING MACHINE.

VOUCHER, LTD., WALSALL.



## COLD-SAWING MACHINE.

THE cold-sawing machine shown in the accompanying illustration has been introduced by Voucher Limited, Walsall, Staffordshire. It is suitable for cutting steel bars up to 4 in. in diameter and tubes of 5-in. outside diameter. It is designed primarily to meet the need for a medium-sized cutting-off machine which can be usefully employed by material stores in factories and stockists. A modified version of this machine, made by the same company, has a saw head which can be rotated through 360 deg. for taking angular cuts, mitreing, and cutting splines. The size of tube that it can accommodate for angular cuts is 3½ in. outside diameter, and the maximum length of spline that can be cut is 8½ in.

The standard V.L.W. 4-in. machine has a 14-in. diameter segmental saw, flange-mounted on a small spindle. The saw is driven by a hardened sprocket which engages slots in the blade of the saw; this method enables the drive to be taken as near as possible to the cutting edge of the saw and thereby minimises the strain which has to be carried by the saw-blade itself. The saw is fed to the work by a feed-screw driven through an adjustable friction device which can be set to prevent an overload, thus safeguarding the saw against breakage.

The vice is suitable for holding any section or size of material without alteration to the jaws, a feature which it is claimed should appeal to those who have to cut a wide variety of stock; the large clamping screw and handwheel provided for this purpose are clearly visible in the illustration. The coolant for the saw-blade is provided by a separate electrically-driven pump. Two ranges of speed, 10 and 20 r.p.m., and 20 and 30 r.p.m., are provided, these ranges being sufficient for the machine to cut hard and tough materials, as well as mild steel. The drive is provided by an electric motor and transmitted by V-belt to the two pulleys. The machine weighs 15 cwt. and occupies a floor space of 57 in. by 30 in.

The modified version of the machine mentioned in the first paragraph is known as the model V.L.W. 360 and it has a similar method of drive to the saw. The height of this machine is arranged so that the work vice is on a level with, and in a line with, the rack supporting the tubes to be cut, so that they can be slid into the machine without lifting. They are then clamped on both sides of the saw and the saw head, after being set over to the desired angle, is fed on to the work. A tube can therefore be cut at either end or in the centre without difficulty. Tubes of 3½-in. diameter can be cut at angles from 90 deg. to 25 deg., and smaller tubes may be cut to more acute angles. This machine is not recommended for the cutting of solid bars as the saw speed and drive are designed for the special purpose of cutting splines in tubes. The feed of the saw to the work can be by a handwheel and screw, by a foot pedal, or by an air-operated mechanism, as required. The machine occupies a floor space of 42 in. by 30 in.

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BRISTOL TYPE 171 HELICOPTER FOR PASSENGER SERVICES.—British European Airways have taken delivery of the first of two Bristol Type 171 Mk. 3A helicopters, constructed by the Bristol Aeroplane Co., Ltd., Filton, Bristol, to be used for passenger services linking London with major provincial cities. The aircraft is basically similar to the Type 171 Sycamore machines in service with the British Army, R.A.F. Coastal and Fighter Commands, and the Royal Australian Navy, but has been specially modified for passenger services, with a re-designed fuselage giving greater luggage space (behind the engine compartment), a side exhaust system, revised instrument-panel layout, and Decca navigational aids. The all-up weight is 5,300 lb. In preparation for the re-opening of passenger services, a Type 171 machine already delivered to B.E.A. has for some time been engaged on operational flight development and crew training.

## SUMMER MEETING OF THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.

THE Institution of Heating and Ventilating Engineers held their annual summer meeting at Southport from June 25 to June 27. It was attended by 262 guests and members and was their largest post-war gathering. The conference took place in the Prince of Wales Hotel and was officially opened on Thursday, June 25, by the Mayor of Southport. Immediately following, an address was given by Professor R. J. Sarjant, O.B.E., D.Sc., of the Department of Fuel Technology, Sheffield University, on "Some Scientific Thoughts on Space Heating." The morning's programme concluded with a paper and discussion on "The Influence of Coal Properties on Combustion, with Particular Reference to a Chain Grate in a Shell Boiler," by Mr. D. C. Gunn, M.Sc., of the British Coal Utilisation Research Association. In the evening members attended a civic reception given by the Mayor and Corporation. On Friday, members formed into five groups to tour places of interest.

On Friday evening a banquet was held, with the President, Mr. F. R. L. White, M.Inst.F., in the chair. Alderman William Tattersall, J.P., M.I.Mech.E., Mayor of Southport, proposed the toast of the Institution and during his address he said how pleased he was, being an engineer himself, to receive conferences such as this in his city. Qualifications and technical ability were, he said, of first importance in the engineering field, as also was the need for research in the many new fields as yet unexplored. Due to the work of the members of the Institution there was, he thought, a degree of comfort in the workshops of many companies never experienced before and he hoped this would help in the drive for increased productivity. Education was a subject about which he claimed to be able to speak with some confidence, having been chairman of the Southport Education Committee. Among the many responsibilities of persons providing education and training was the need to ensure that the right person received the right training for the job. The President, in his response, thanked all who helped in organising the conference. He gave members a few details of the new and enlarged home in London which the Institution will shortly acquire, but felt that it was not yet an opportune moment for announcing the actual address as financial negotiations were not complete. On Saturday morning the Summer General Meeting was held; it was followed by a paper and discussion on "Air Conditioning: Some Practical Aspects of Control," by Mr. W. D. Forbes, A.M.I.Mech.E., of British Nylon Spinners, Limited.

### SPACE HEATING.

In the address by Professor Sarjant, he said that, from the really scientific standpoint, the problem of space heating had become one of controlling the temperature of our surroundings to a value that depended on many considerations, all of which were subject to scientific assessment and control. That the economic factor was an over-riding one went without saying. An interesting fact reported by Major S. F. Markham was that reference to a map of the world revealed that the average isotherm of 70 deg. F. passed through every one of the ancient centres of civilisation. In fact, there never had been a great ancient civilisation where there were extremes of heat and cold. With the advent of the use of fuel, combined with improvement in building and the perfection of glazing, man's control over the limitations imposed by climate had become enhanced. It was not fully realised, however, that the fuel used for space heating in this country was a considerable portion of the total consumption.

In work carried out in Sheffield, directed towards the study of smoke abatement and heat release from both coal and gas flames, the problem of turbulence has been shown to be of particular importance. The problem resembled that of the domestic fire-place, since it was required to determine how smoke could be eliminated on a heating

material in a cold furnace. The investigations showed that a combination of a new type of mechanical stoker and a combustion chamber could be designed to eliminate smoke in heating up from cold. Both the mode of admission and the velocity of the secondary air were said to be essential requirements, together with a minimum wall temperature of 750 deg. C. in the combustion chamber. Earlier work in the smoke tubes of shell-type boilers had evaluated the effect of turbulence on the heat transmission and indicated that the increase in heat transmission by turbulence promoters was directly proportional to the increased length of the path of the gas in traversing a given heat-exchanging area.

Heat transmission in furnaces, particularly as regards heat losses, had some analogy with heat losses from buildings, and the complexities of the U-values of heat transfer found in buildings had their counterparts in the furnace. In this problem, and in the heating of any solid body, mathematical techniques, including the use of electrical analogues, had a place. In the treatment of heat losses from corners and irregular shapes in furnace brickwork, relaxation techniques had been used with success. Relaxation was a process of solving simultaneous equations applicable to a pattern of temperature distribution. Numerical integration of finite difference equations was a very powerful technique for determining the distribution of temperature under conditions of variable flow of heat, such as occurred in all practical cases of heating and cooling. This technique, operated in two dimensions, was recently used at the Department of Fuel Technology in Sheffield to determine the temperature inside ingots during cooling and heating, and thereby to design heating schedules and improve the efficiency of the heating plant.

Some of the new techniques used in heating and ventilating research for solving these problems in the field of low-temperature heating which offered much scope and promise of success, were the tracer technique, the Katharometer and ultra-violet light absorption, the ionisation anemometer using X-rays emitted from gold for measuring low velocities, and the copper-sphere anemometer.

### The Influence of Coal Properties on Combustion.

In the paper presented, Mr. D. C. Gunn described an investigation of the effect of coal properties on the efficiency of an Economic boiler equipped with a chain-grate stoker. The coals were chosen by a panel of the R/16 Committee, the experimental work was commenced early in 1948, and the equipment used was situated at the B.C.U.R.A. Experimental Station at Leatherhead. The coals were tested at a variety of firing rates, sizes, grades and surface-moisture contents, the performance of the boiler being observed largely in accordance with B.S. 845, "Commercial Acceptance Tests for Steam Boilers."

The results of the investigation, which were illustrated by tables, established that a small coal under ¼ in. rank had very little effect on boiler output or efficiency, that the fines content (⅛ in. or less) was probably the most important attribute of any rank, and that an excessive fines content led to a serious loss of efficiency and output if the coal was dry. Coal which had been sufficiently wetted, however, incurred only negligible losses when burned on a chain grate. The ash content of the coal had a very variable effect on boiler efficiency, and, in some cases, a loss of 0·25 per cent. in efficiency for every 1 per cent. increase of ash content was observed, but occasionally the loss was as high as 1 per cent. for every 1 per cent. increase in ash. Thicker fuel beds and finer coals tended to produce the highest losses, due to clinker adhering to parts of the stoker structure. Certain reputedly difficult coals were burned satisfactorily when the material over ¼ in. was rejected and the remainder sufficiently wetted. The author raised the question of how the results might have differed if the work had been conducted on another type of shell boiler. Neither the time nor the facilities were available, he said, for answering this question directly, but he saw no reason to suppose that the combustion conditions would in any way have been affected, and the transposition of the results to another boiler was purely an inferential heat-transfer problem. The effect of coal properties on other types of stoker could not reasonably be inferred from these experiments as it was known that the behaviour of coals on coking stokers, sprinkler stokers, and probably under-feed stokers, was sufficiently different to necessitate the work being extended to cover these firing appliances.

### Control of Air Conditioning.

In his opening remarks, Mr. W. D. Forbes said that the air-conditioning requirements of certain industrial processes involved tolerances on both relative humidity and temperature which were considerably narrower than were necessary for personal comfort. One such case was the manufacture of nylon yarn, where the process could be easily disrupted by poor conditions. For this reason, a detailed survey had been carried out in his factory, which was engaged in this type of work, on the different types of instruments used in the control of the air-conditioning system. Some of the instruments investigated in the field of relative humidity were of the wet-bulb and dry-bulb type, the whirling psychometer, the aspirated psychometer, the single dew-point hygrometer, and a dew-point indicator employing photo-electric detection. Plant controls and performance were also investigaged, together with certain factors affecting the efficiency of air distribution, mainly local variations in heat gain, and the method of exhaust-air extraction. The conclusion reached after the tests was that under reasonable circumstances the instruments would give a performance of ± 5 per cent. relative humidity and ± 5 deg. F. dry-bulb temperature, when used in a factory. Such figures were, however, dependent upon the design of the building in which the instruments were installed and the selection of an instrument suitably designed and set for conditions that came well within its characteristic performance curve.

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**Map Exhibition Extended.**—The Exhibition of Maps at the Royal Institution of Chartered Surveyors, Great George-street, London, S.W.1, which we described in our issue of June 19 (page 787, vol. 175), is to be extended for a further period, up to July 25. This extension has been brought about by the considerable interest shown in the unique collection of exhibits, among which are numerous rare manuscript maps, early atlases, first editions, and early surveying instruments.

## MOBILE VAN FOR HIGH-VOLTAGE CABLE-TESTS.

CROMPTON PARKINSON, LTD., LONDON.

## MOBILE VAN FOR HIGH-VOLTAGE CABLE TESTS

A MOBILE van for the direct-current testing of cable installations at 33 kV has been placed in service by Crompton Parkinson, Limited, Aldwych, London, W.C.2, to facilitate operations on sites where construction work is in progress and to ensure greater safety than is possible when temporary equipment is used. The equipment can also be used for certain high-voltage tests on switchgear and transformers. The unit consists of an alternator, two-valve rectifier, electrostatic voltmeter and control board. These are all installed in a 15/20-cwt. Morris van which can be driven to a suitable place on the site. Two single-core rubber-insulated flexible leads are then run out and connected to the circuit under test. All the equipment is mounted so as not to be affected by vibration and shock, the valves being suspended horizontally in a pair of resilient rubber mountings which are held in a Perspex cradle suspended from the roof.

The single-phase alternator, which has an output of 1·65 kVA at 230 volts, 50 cycles, when running at 3,000 r.p.m., is driven from the engine gearbox of the van through wheels, chains and a lay-shaft to give an increase in speed of 1 to 3·5. Its excitation is adjusted to generate the rated voltage, and the input voltage to the step-up transformer is altered by an induction regulator. This regulator is operated by a direct-current motor, which is supplied from the van's 12-volt battery and is controlled by push-buttons on the control panel, shown in the accompanying illustration. This panel also carries the alternator voltage regulator, as well as a voltmeter, ammeter, frequency meter valve-filament controls, a single-pole circuit-breaker and low-voltage fuses. Alternatively, the valves, which are connected to give a maximum direct-current output at 120 kV between poles, i.e., at 60 kV to earth, can be energised from any 230-volt single-phase supply.

The van carries additional equipment, such as a Wheatstone bridge and insulation testers, for fault localisation and field tests on cable systems operating up to 33 kV. The operators are protected from contact with live high-voltage equipment by glass screens above the control panel, through which a clear view can be obtained of the electrostatic voltmeter, the heater-circuit milliammeters and the area beyond the back of the van.

# INSTRUMENT FOR REGULATING METERED AIR SUPPLIES.

WILLIAMS AND JAMES (ENGINEERS), LTD., GLOUCESTER.

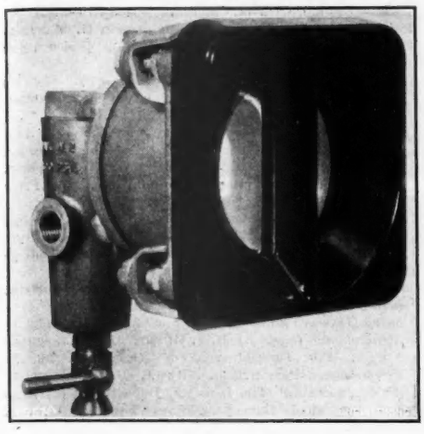
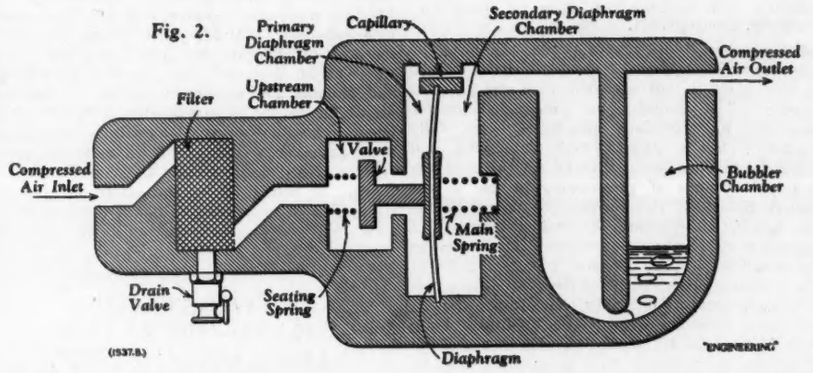


FIG. 1.




## INSTRUMENT FOR REGULATING METERED AIR SUPPLIES.

THE levels of liquids in vessels are often measured by a remote manometer, which may be below or above the bottom of the vessel and which may require to be isolated from the contents of the vessel. A dip tube installed in the top of the vessel is then connected to one leg of the manometer and the other leg is directly connected to the top of the vessel, a supply of compressed air being "bubbled" through the dip tube to obtain a false zero reading in the manometer. The manometer reading can then be made to vary directly with the liquid level in the vessel. Up to the present, the regulation of flow and pressure of the air passing through the dip tube has been carried out by a flow-control needle valve and a pressure-reducing valve, and a visual indication has been provided by a "bubbler" chamber fitted with a window through which the bubbles of compressed air can be seen.

Recently, an instrument known as the Pneumerstat has been developed by Messrs. Williams and James (Engineers), Limited, Chequers Bridge, Gloucester, in collaboration with the Dyestuffs Division of Imperial Chemical Industries Limited. It incorporates the control valves and bubbler chamber in a single unit, thus eliminating several pipelines and connections, simplifying installation and maintenance, and reducing possible sources of compressed-air leakage. In the Pneumerstat, which is illustrated in Fig. 1, the pressure and flow setting are adjusted by the manufacturers and cannot readily be altered; the instrument, therefore, will give a consistent and accurate performance. The Pneumerstat can also be applied to the measurement of density, to continuous gas sampling, and to the accurate regulation of a slow feed of liquid.

Fig. 2 above shows a diagrammatic section through the instrument. When the Pneumerstat is in operation, the inlet air pressure will always be greater than that at the outlet. Compressed air entering the instrument passes through a filter into an upstream chamber, thence, by way of a valve, to one side of a chamber divided by a spring-loaded diaphragm. The air in the primary diaphragm chamber exerts a force on the diaphragm, opposing the main-spring load, and causing the diaphragm to flex, allowing the valve-seating spring to close the valve, shutting off the air supply to the primary diaphragm chamber. From the latter, air flows through a capillary into the secondary diaphragm chamber, and exerts a force on the diaphragm reinforcing the main-spring load. When the air pressures on both sides of the diaphragm are equal, the valve will open. From the secondary diaphragm chamber the air passes to the air outlet through a bubbler chamber, filled with a special fluid. Air bubbling through this chamber gives an indication of the flow through the instrument.

If the outlet pressure increases, it will cause a pressure rise in the secondary diaphragm chamber. The valve will therefore still be open, and a small air flow will still pass through the bubbler chamber. Should the outlet pressure decrease, it will cause a pressure drop in the secondary chamber, and the valve will close until the flow through the capillary causes a balance of air pressure across the diaphragm. Thus, there is always a flow through the bubbler chamber irrespective of the outlet pressure, although the rate of flow will vary slightly with changes in outlet pressure.

## FIFTH INTERNATIONAL MECHANICAL ENGINEERING CONGRESS, AT TURIN.

"PRODUCTION and Assembly Methods for Components in Mechanical Engineering" has been taken as the theme for the Fifth International Mechanical Engineering Congress, which will take place at the Palazzo delle Esposizioni del Valentino, Turin, from Friday, October 9, to Thursday, October 15, 1953, both dates inclusive. The congress will be held during the course of the Salone Internazional della Tecnica, in order to give those attending the opportunity of visiting that exhibition.

Prior to the congress, a cocktail party for those participating will be held on the evening of October 8 in the Teatro Nuovo of the Palazzo, and the opening session will take place on the morning of the following day, October 9, at which an inaugural address will be delivered by Professor V. Valletta, the President of the Fiat group of companies. Thereafter, working sessions of the congress have been arranged for the afternoon of October 9, the morning and afternoon of October 10, the afternoon of October 12, and the morning and afternoon of October 13. Sunday, October 11, will be devoted to an excursion to places of interest, and visits to local factories have been arranged for the mornings of October 12 and 14. There will be a congress banquet on the evening of October 14, and the final working sessions and closing of the congress will take place on October 15.

More than 90 technical papers had been promised to the organising committee at the end of May, and offers of several more were expected. These have been arranged under eleven headings, namely, machining with cutting tools; machining with electricity; finishing; foundry practice; precision casting; stamping and forging; extrusion, cold forging and deep drawing; sintering; welding; other assembly methods; and comparison of various methods. Papers will not be read but copies will be circulated, from the beginning of September, to all registered members of the congress, and the discussion of the papers will form the principal business of the working sessions. The official languages for the papers and discussions will be English and French. A separate programme of events has been arranged to meet the needs of ladies accompanying members of the congress.

The International Mechanical Engineering Congresses are organised with the support of the national trade associations of 14 European states, including Austria, Belgium, Finland, France, Germany, Great Britain, Holland, Italy, Spain, Sweden, and the Scandinavian countries. This year's congress is the special responsibility of the Italian trade association, the Associazione Metallurgici Meccanici Affini, Via Massena 20, Turin. The permanent secretariat of the organising committee for the congresses is situated at 10, Avenue Hoche, Paris, 8e, and the British Engineers' Association, 32, Victoria-street, London, S.W.1, represent the committee's interests in the United Kingdom. Application forms and further information may be obtained from the Association.

During the week immediately following this year's congress, from Friday, October 16, to Thursday, October 22, there will be a study tour, by motor coach, of prominent industrial undertakings in northern and central Italy, for which two separate itineraries are being arranged.

## EXTENDING THE ACTIVITIES OF CONSULTING ENGINEERS.

IN their annual report, the Council of the Association of Consulting Engineers draw particular notice to their contention that there exists a wasteful employment of qualified engineers in Government Departments and nationalised industries, especially in regional and local offices. It is pointed out that design and supervision of civil engineering works are the prerogatives of consulting engineers, who maintain staffs trained for this work and experienced in the requirements of public and private industrial clients. It is suggested, therefore, that the advice, knowledge of design and supervision by the consultants and their staffs are likely to be on a wider and more competent basis than those of the engineering staff of an official department. From this, it is argued that considerable Government economy might be effected if regional staffs were reduced to such numbers as are necessary to undertake only routine work and maintenance, the design of all new works being referred to the consultants. It is further pointed out that such a practice would assist in developing the consultant's offices so that it would be easier for them to procure and to undertake work from overseas. Such an extension of activities by the consulting engineers is one which the present Government, as well as their predecessors, have often demanded as a first step towards increasing exports, but which the Association suggest is not practicable unless sufficient work is forthcoming at home for them to build up their staffs. In order to gain work overseas, it is considered that offices must, in many cases, be established in the country concerned: Canada and the Caribbean are indicated as areas being most suitable for such activities, although fierce and ever-increasing competition must be expected.

## NOTES ON NEW BOOKS.

*Prestressed-Concrete Statically Indeterminate Structures: Symposium Proceedings.*

Edited by R. P. ANDREW, M.A., Ph.D., and P. J. WITT. Cement and Concrete Association, 52, Grosvenor-gardens, London, S.W.1. [Price 25*s.* net.]

IN September, 1951, a symposium, organised by the Cement and Concrete Association, was held in London at which both the theoretical and practical aspects of continuity in prestressed-concrete statically indeterminate structures were fully discussed. Seven papers were submitted and detailed reference was made to all three of the principal systems of prestressing in use in the United Kingdom, the Freyssinet, Magnel-Blaton and Lee-McCall systems. A detailed summary of the papers themselves was published at the time in ENGINEERING, on pages 676 and 707, vol. 172 (1951). The volume of Proceedings of the symposium, now published, contains not only the original papers, but also a verbatim report of the lively discussion that followed each paper, together with a list of members attending the symposium and an index to the contributors. Particularly useful are the authors' introductions to their own papers—especially is this true of the theoretical papers—for the explanations given in the originals were often brief to the point of obscurity, a difficulty that was later remedied when the authors presented their papers. The Proceedings form the first collection of authoritative papers on the subject and as such should prove of value to engineers concerned with this medium of construction.

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*Permanent Magnets.*

Permanent Magnet Association, 301, Glossop-road, Sheffield, 10. [Price 10*s.*]

THIS publication is a joint compilation by the members of the Permanent Magnet Association and is intended to provide authoritative information on various types of the fundamental piece of apparatus made in the title. The permanent magnet no longer consists of a natural lodestone or a single piece of artificially-excited steel, but may be and probably is one of a very numerous species which, as the result of much research, have been designed to perform different functions and to operate efficiently under various conditions. After an account of the Association's research laboratories, which include a foundry with moulding and core-making facilities, as well as metallurgical and chemical sections and engineering and instrument workshops, there follows an excellent chapter on the theory of magnetism and magnet design. Full information is next given about the properties of the wide range of materials now available for magnet manufacture and of their characteristic properties. This section is clearly written and well illustrated with graphs and may be said to form the main portion of the book. Subsequently, the effects of mechanical shock and alternating fields on permanent magnets are described; and there are also sections on such practical matters as magnetising, testing, demagnetising, storage and applications. In conclusion, there is a useful glossary of technical terms. The book should form a useful introduction to a subject which is not without its complications, though to say that it will enable "the reader to progress far towards designing his own magnets efficiently" may be an over-statement.

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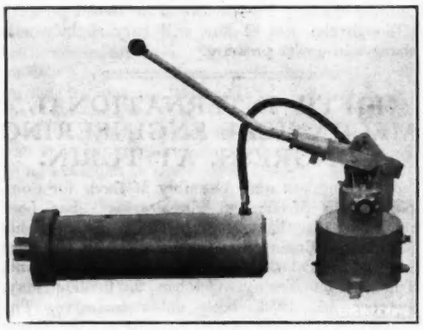
*Manual on Rock Blasting.*

Aktiebolaget Atlas Diesel, Stockholm, and Sandvikens Jernwerks Aktiebolag, Sandviken, Sweden. [The Atlas Diesel Company, Limited, Beresford-avenue, Wembley. [Price 5*l.* 5*s.* net.]

THIS new manual is edited by K. H. Fraenkel, Stockholm, and is published in loose-leaf form, the text being in English, French, German and Swedish, in parallel columns. It owes its origin to the International Congress on the Driving of Tunnels in Rock, held in Paris in 1949, when it became apparent that there was a definite need for the interchange of ideas, on an international basis, between mining and civil engineers engaged in this type of operation. The various sections are contributed by 14 eminent Continental authorities on the subject, and, during the current year, contributions by a further 13 British and Continental authorities are to be issued. The manual is in eight sections, covering geology, terminology, rock-blasting methods, planning and practical results, compressed-air supply, drill steels, explosives, methods of charging and firing, and ventilation; the text is illustrated by numerous photographs and diagrams, all captioned in the four languages used. The section on rock-blasting methods includes time studies of the cycle of drilling, blasting and mucking, and it concludes with a description of the tests used to determine the "drillability" of rocks. It seems to be the intention that this manual shall become the standard work on British and Continental rock-blasting and tunnelling practice.

## TWO-STAGE HAND-OPERATED HYDRAULIC PUMP.

AMONG the wide range of pumps and oil-hydraulic accumulators available from Chamberlain Industries, Limited, Staffa-road, Leyton, London, E.10, is the new "Duo" two-stage hand-operated pump and accumulator shown in the accompanying illustration. The standard pump is available either with or without a pressure-release key and can be fitted above an oil reservoir of a half-gallon capacity, as shown in the illustration, or above a two-gallon reservoir. The reservoir has three lugs making it suitable for foot mounting.



The pump housing contains two cylinders—one low-pressure, and the other a high-pressure cylinder working up to a maximum of 5,000 lb. per square inch—which are both connected, by a system of drilled oilways, to a common delivery point, from which a short length of flexible hose leads to the accumulator. To ensure that no undesirable swarf should be left in the cylinder cavities or in the oilways, and to make maintenance easy, the pump housing is drilled and/or bored right through a solid billet of about 4⅛ in. diameter by 4½ in. high. The ends of the drilled holes are closed by screwed valve housings or plugs. Both the inlet valves between the reservoir and the cylinders, as well as the valves in the delivery oilways are of a simple one-way floating-ball type. The pump, as well as all the accessories, are made throughout of steel.

The pump is first operated on the low-pressure cylinder, delivering 0·12 pint of oil at each stroke, until the ram of the accumulator is brought into its working position. At that point the low-pressure cylinder is cut-out by releasing the connecting rod from the handle, which can then be actuated without moving the piston. This automatically brings the high-pressure pump into action; while the low-pressure cylinder is working, the oil will be delivered by both cylinders but with the low-pressure piston freed from the handle that cylinder becomes a static reservoir and oil is pumped only through the high-pressure cylinder. The delivery of the latter cylinder is only 0·01 pint (0·33 cub. in.) per stroke, permitting a close control to be maintained over the output, which can be raised to a maximum pressure of 5,000 lb. per square inch.

## BOOKS RECEIVED.

*Canada. Department of Mines and Technical Surveys. Mines Branch. Industrial Water Resources of Canada.* Water Survey Report No. 4. *Columbia River Drainage Basin in Canada*, 1949-50. By J. F. J. THOMAS. The Director, Department of Mines and Technical Surveys, Mines Branch, Ottawa, Canada. [Price 75 cents.]

*Résistance des Matériaux.* By PROFESSOR G. MANUEL. Dunod, 92, Rue Boneparte, Paris (6e). [Price 1,860 francs.]

*A Statistical Primer.* By DR. F. N. DAVID. Charles Griffin and Company, Limited, 42, Drury-lane, London, W.C.2. [Price 22*s.* net.]

*The Elements of Astronomy for Surveyors.* By the late R. W. CHAPMAN. Fifth edition, revised and enlarged by J. B. MACKIE. Charles Griffin and Company, Limited, 42, Drury-lane, London, W.C.2. [Price 26*s.* net.]

*Vermuyden and the Fens: A Study of Sir Cornelius Vermuyden and the Great Level.* By L. E. HARRIS. Cleaver-Hume Press Limited, 42*a*, South Audley-street, London, W.1. [Price 21*s.* net.]

*Canada. Department of Mines and Technical Surveys. Mines Branch.* Technical Paper No. 3. *The Colorimetric Determination of Copper with 2,2-Diquinolyl in Minerals and Ores.* By R. J. GUEST. [Price 25 cents.] No. 4. *The Determination of Aluminium by the Fluorophotometric Method.* By J. B. ZIMMERMAN. [Price 25 cents.] The Director, Department of Mines and Technical Surveys, Mines Branch, Ottawa, Canada.

*Ministry of Transport. Railway Accidents. Report on the Accident which Occurred on 22nd December, 1952, at Wheatsheaf Junction on the Western Region, British Railways.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 6*d.* net.]

*Mitteilungen aus dem Institut für Baustatik an der eidgenössischen technischen Hochschule in Zürich.* No. 25. *Versuchsbericht über das Ausbeulen der auf einseitigen, gleichmässig und ungleichmässig verteilten Druck beanspruchten Platten aus Avional M, hart vergütet.* By PROFESSOR F. STÜSSI, DR. C. F. KOLLBRUNNER, and DIPL.-ING. M. WALT. [Price 18 Swiss francs.] No. 26. *Ausbeulen rechteckiger Platten unter Druck, Biegung und Druck mit Biegung.* By PROFESSOR F. STÜSSI, DR. C. F. KOLLBRUNNER, and DIPL.-ING. H. WANZENRIED. [Price 6·25 Swiss francs.] Verlag Leemann, Stockerstrasse 64, Zürich, Switzerland.

*Mitteilungen über Forschung und Konstruktion im Stahlbau.* No. 12. *Stahlfundamente für Turbogruppen.* By DR. CURT F. KOLLBRUNNER and DIPL.-ING. OTTO HAUETER. [Price 3·50 Swiss francs.] No. 15. *Brücke Bever Km. 95,381 der Strecke Chur-St. Moritz der Rhätischen Bahn.* By DR. CURT F. KOLLBRUNNER and DIPL.-ING. H. HILTEBRAND. [Price 5 Swiss francs.] No. 16. *Dreimomentengleichung des kontinuierlichen Druckstabes mit Querbelastung.* By DR. CURT F. KOLLBRUNNER and DIPL.-ING. OTTO HAUETER. Verlag Leemann, Stockerstrasse 64, Zürich, Switzerland.

*Mitteilungen der T.K.V.S.B.* No. 4. *Der Einfluss der Poisson'schen Zahl auf die Stabilität rechteckiger Platten.* By DR. C. F. KOLLBRUNNER and DR. G. HERRMANN. No. 5. *Die Entwicklung des neuzeitlichen Stahlbrückenbaues in Deutschland.* By DR. W. WOLF. No. 6. *Das Schweissen in Amerika und seine Anwendungen im Bauwesen.* By DR. C. F. KOLLBRUNNER and DR. G. HERRMANN. Verlag Leemann, Stockerstrasse 64, Zürich, Switzerland.

## TRADE PUBLICATIONS.

*Plastics.*—We have received an illustrated booklet entitled "The Lorival Plan," which has been published by United Ebonite & Lorival, Ltd., Little-lane, near Bolton, Lancashire. It deals briefly with the history of the company, and gives details of their manufacturing facilities for producing mouldings, sheet and extrusions in polyvinyl-chloride, polythene, polystyrene, diakon and cellulose acetate.

*Centrifugal Fans.*—Specifications of the full range of forward-curve, paddle-blade and backward-curve centrifugal fans manufactured by the Airscrew Co. and Jicwood, Ltd., Weybridge, Surrey, and descriptions of their characteristics and applications are given in a "Red Book," issued recently.

*Hot-Water Valves.*—The Rheostatic Co., Ltd., Slough, have sent us copies of their lists Nos. 121 and 142 describing "Satchwell" automatic valves for the control of high-pressure hot-water distribution.

*Mine Signalling System.*—The system they have designed for signalling in underground shafts where the atmosphere is "unsafe" is described in a pamphlet received from Automatic Telephone and Electric Co., Ltd., Strowger Works, Liverpool, 7.

*Amplitude-Modulated Voice-Frequency Telegraph System.*—Details of their 24-channel amplitude-modulated voice-frequency telegraph system are given in a pamphlet issued by Standard Telephones and Cables Ltd., North Woolwich, London, E.16.